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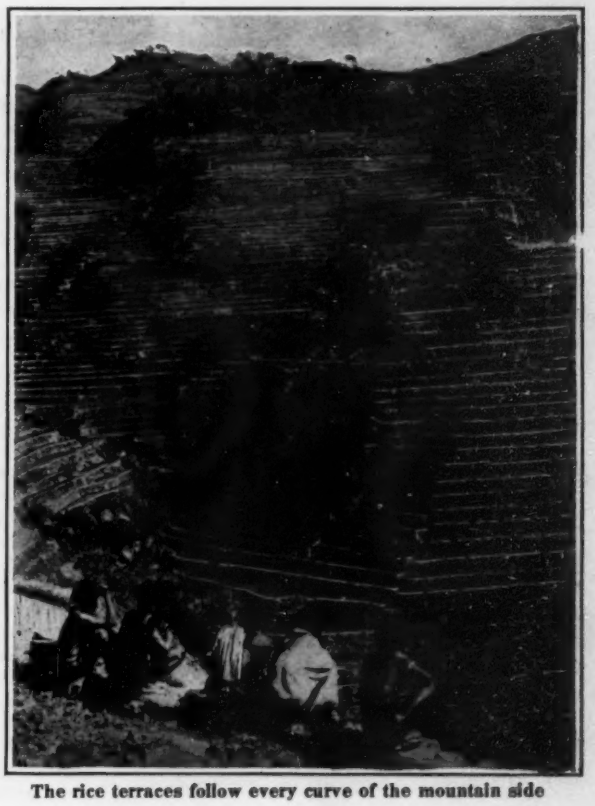
How the Philippine Islanders grow their rice on huge terraces high up in the mountains



The rice terraces follow every curve of the mountain side

Masterpieces of Primitive Engineering

THAT work which, in its visible results, must be recognized as an engineering undertaking of considerable magnitude does not necessarily involve knowledge of slide rule and handbook, or even the possession of respectable tools, is demonstrated by the agricultural achievements of some of the Philippine Islanders. These Igorots would on every other ground be classified as savages; but their methods of cultivating the ground are alone sufficient to win them a rank as barbarians.

Rice, of course, is their major crop. Now rice demands water in profusion, as everybody knows; so we ordinarily think of it as being grown in flat regions of considerable area, which can be flooded and kept flooded. Accordingly if we were confronted with the suggestion that we grow rice on the precipitous sides of the Philippine mountains, we might well be excused if we should pass the proposition by with a smile. Not so the Igorot, however; with no tool save a stick, with no power save that of arm and leg, he has converted whole mountains into giant flights of level spaces, and provided means to irrigate them. A glance at our pictures will make it obvious that here is a story worth telling.

Ethnologists are not wholly agreed as to where the Igorots learned to build these rice sementeras, as they are called. The art might be an indigenous one, it might have been introduced bodily from China or Japan, it might have spread slowly from the south. The second suggestion seems offhand the most plausible one, since rice terraces are found in China and Japan, while Chinese traders are known to have visited Luzon regularly as early as the thirteenth century, and Japanese but little later. But there is no record that they ever went north of Manila, where alone the Igorot sementeras are found. Moreover, they did not sojourn in the island, but traded through traveling native merchants who came to them on the coast; so that whatever they might have introduced, it would hardly be agriculture, and still less a feature which is met only at a distance of three or four days journey from the sea. On the whole, probably the most reasonable assumption is that the terracing processes are a survival of a very early culture which spread from the nest or nests of the primitive Malayan stock in the islands south of the Philippines, leaving marks along the way.

An idea of the size of these terraces may be got from the natives working at the upper right—mere dots in the water

Like all primitive agricultural labor, the terracing is a religious ceremony, accompanied by elaborate rites. The whole process is essentially one of leveling shelves into the mountain side. The earth is first cleared; the soil is carefully removed and placed in a pile; the rocks are dug out; the ground is shaped, excavated behind and filled in front, until a level results. This is no light task, with no tools save sticks. When a big boulder is encountered, there may be days of patient, laborious digging, like an animal, and prying with hands and sticks.

Once the ground is well leveled—and the Igorot can recognize this state of affairs only by sense or instinct, since a testing tool is far beyond him—the soil is put back over the plat, rich soil from another location being frequently added to that previously removed. In order to provide for flooding, every plat must be walled in on all sides where the mountain does not furnish a natural wall. For this purpose boulders and water-worn stones from the creek beds are employed. The walls are formed of these, piled together, undressed and without cement or earth; and of course in many places the barrier must be carried down below the level of the terrace, on the outside, as a retaining wall. Such walls will run from one to thirty feet in height, and in at least one extreme case have been observed as high as seventy-five feet. They are carried to a height which will bring them about fifteen inches above the flood water level. These walls are quite flat across the top, which is from twelve to eighteen inches broad; and this furnishes the path among the sementeras. An easy flight of steps for ascent and descent is provided by means of single rocks projecting from the front of the wall at regular intervals. Of course a mountain is terraced

(Concluded on page 238)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Notice to Our Readers

FROM letters which have been received recently by the Editor, it appears that certain unauthorized canvassers or agents have been using our name in soliciting biographical sketches, to be inserted in what is termed the Biographical Section of the Encyclopedia Americana. It seems that these agents represent themselves as coming from the SCIENTIFIC AMERICAN, or from the so-called Scientific American Compiling Department. One of them, we are informed, has used on his card the title "Scientific American Compiling Director." The proposition offered by the agent is that the biography of the individual, who is probably the head of some leading business or corporation, shall be published in this Biographical Section, and that it shall be embellished by a portrait of the individual; that the biography shall be published without expense; but that the cost of the portrait shall be defrayed by the individual honored by the insertion in the Encyclopedia, at an expense which is generally fixed at $250.00, or more, according to the wealth and importance of the individual.

We desire to warn our readers and the public that we are not in any way connected with the Encyclopedia Americana, or with the biographical enterprise above described, and that the use of the name SCIENTIFIC AMERICAN or "Scientific American Compiling Department" is without our authority or consent.

Another Year

IN spite of its late starting, last year's campaign for the home production of food was a distinct success. This year, with no excuse of late starting to be advanced, there is accordingly no reason why we should not throw last year's showing completely into the shade.

Nobody is this year taken by surprise by the demand that he do something, personally, to increase the nation's food supply. There can be no legitimate unpreparedness, either mental or material. The idea of food production by the consumer is now a familiar one, and we have had all winter to make up our minds what we are going to do and to gather our resources for the doing. Likewise, many costly mistakes will be avoided. The man who buried many bushels of new potatoes in his back yard, selecting these in preference to the old ones because they were young and strong, will not repeat this performance. And, in general, the reasons why millions of dollars worth of the seed that was planted last year failed to come up will be now pretty well understood; and this is well, for we are not this year in a position to bury much seed permanently in the earth. We have, in brief, learned not only what to do, but likewise how to do it.

Moreover, the possibilities are better formulated this March than they were last April and May. We know now what to try and what not to try; we know far better how to go about the getting of land to plant; and the list of alternative activities for the man so fixed that he cannot, with profit, dig in the ground, is larger. We are much better able now than ten months ago to make our individual undertakings check up with our individual abilities, circumstances and resources.

Some of us will grow vegetables. A few of us will be in a position to see to it that would-be gardeners have land on which to work. Very many of us will keep some chickens or a pig or two—the two important factories for small-scale conversion of food that humans cannot eat into food that they can. Some of us will help convert to good use the annual crop of wild fruits and berries, so much of which normally goes to waste. Most of us can do something to cut down waste in consumption—and here is meant not at all the curtailment of consumption which has been and will be called for from time to time, but rather the prevention of actual waste in connection with consumption.

The main point, however, is that every single one of us has time, this year, to find out what he can do and how he can do it. Excuses of any sort whatever are wholly out of order. Every American citizen who fails to do his share of this summer's food production and food stretching and food saving is, in effect, giving aid and comfort to the enemy. So let every one of us find out what he is to do, and prepare to do it with our boasted American effectiveness. Begin now!

Bridge versus Ice Blockade

THE recent ice blockade, which figured so largely in producing the coal famine in New York, affords an additional argument to those already existing for the construction of a great railroad bridge across the North River. The idea, as our readers are well aware, is not a new one—in fact it has many times been described and strongly advocated by us, since it was first worked out on a practical basis over a quarter of a century ago by Gustav Lindenthal, the engineer who designed the Hell Gate Bridge.

The very waters which constitute New York the greatest port in the world are at the same time a serious handicap to the free flow of passenger and freight traffic into and out of Manhattan Island. With the exception of the New York Central and the New Haven and Hartford Railroad, all the great railroad systems from the south and west come to a full stop on the Jersey side of the North River; and until the Pennsylvania Railroad built its tunnels and magnificent terminal on Manhattan Island, the transfer of passengers and freight was done by ferry and lighter. The Hudson Tubes, built a little later, are for passenger use only. They were not built for and could not very well carry freight.

The system of ferriage, by which passenger and vehicular traffic crosses the river, is a source of delay—(in the case of automobiles, a delay that is extremely exasperating)—and the system of lighterage, because of the double loading and unloading involved, is not only a cause of delay but adds greatly to the charges for getting freight from the west into Manhattan Island. Furthermore, the severe winter weather has shown that in times of national stress, such as that occasioned by the present war, the lack of bridge facilities may become positively calamitous.

The introduction of successful electric traction by getting rid of steam and asphyxiating gases removes the fundamental objection to a tunnel service below the North River; but a single tunnel carries only a single track and obviously this means of transit entails an extremely high cost in proportion to the track capacity afforded. In fact, for the same trackage capacity, tunnels would cost fully three times as much as bridging.

The bridge across the North River, as first designed by Lindenthal and subsequently modified, would be a truly gigantic structure; but in spite of its proportions it would be well within the scope of modern bridge engineering; and if it were undertaken as a joint Governmental, State and private enterprise, the question of finance would not involve any uncertain problems.

Because of the great depth of rock, it is impossible to put any pier in the middle of the North River, and, consequently, the clear span of the suspension bridge (it would have to be suspension, since cantilever construction would be altogether prohibitive in weight and cost), would have to be thirty-one hundred feet, and the four steel towers for carrying the cables would rise six hundred and fifty feet above the coping of the granite foundations. To secure the necessary lateral girder depth to withstand the enormous wind load, the floor of the bridge would have to be of great width, and since the structure will carry two decks there would be ample accommodation for traffic present and future. The bridge is designed to carry eight railroad tracks, six rapid-transit tracks, two roadways and a promenade. And so heavy will be the bridge structure itself, that if all these tracks and roadways were loaded end to end, the total live load, as it is called, would be insignificant compared with the dead load of the great structure itself.

Outside of the Pennsylvania Railroad, which has tunnel entrance to New York, there are eight other railroads that bring up short on the Jersey side of the North River, and these railroads number among them no less than thirty tracks.

The proposed span is to have a large classification yard on the Jersey side, from which the segregated freight would converge to the great bridge to which the traffic would ascend by grades no greater than those existing in the Pennsylvania tunnels. On the New York side would be erected a central station, with connections to the Pennsylvania and New York Central terminals, and the tracks would be continued on a double-deck structure along West Street, down to the Battery. From the Battery two tracks, partly elevated and partly in tunnel, would be extended up the East River—the whole system thus engirdling Manhattan Island. Empty cars would be returned to the Jersey side by a two-track tunnel near the Battery. Associated with the elevated structure would be a series of warehouses and manufacturing establishments arranged somewhat on the Bush System in South Brooklyn; and spurs would be run off from the main structure into the various buildings, such freight as did not go into storage being lowered by gravity for distribution at street level by motor trucks.

Now, here is an improvement which should have been built decades ago. If the various railroads terminating in New Jersey had been as far-sighted and broad-minded as the great Pennsylvania Railroad, the bridge, the terminal, the marginal railroad and the warehouses would have been in full swing today. Arguments that were pressing for the construction of the bridge in 1890 are ten-fold more pressing today. The preliminary work, engineering, financial and legislative, should be done at once, so that when the great day of peace comes, this urgently needed improvement can be pushed through to completion.

Industrial Physiology

THE paradox of increasing the output of a factory by diminishing the hours of labor is not altogether a novelty, but the elucidation of this phenomenon, along with others of a kindred nature, constitutes one of the latest tasks of applied science. Among the innumerable products of the great war is the science of "industrial physiology." How this science has come into being and what it is now doing for mankind we learn from a notable paper by Dr. Frederic S. Lee, lately published in the *Public Health Reports*.

The problem of getting the maximum amount of labor consistent with a high quality of the same out of the human machine is one which interests not only employers, but also the independent worker. Hence Dr. Lee's paper, while dealing only with conditions in industrial establishments, appeals to a larger audience than he probably suspects. Anybody who makes his living by piecework—be it mending pots and pans or writing magazine articles at a space-rate—must have striven to solve this problem in the light of his own experience; and now enters the industrial physiologist, to supply the *rationale* for our empiric wisdom.

Reverting to the problem of the factory worker—war industries have furnished the most important laboratory material for the investigations in question. In Great Britain the subject of industrial fatigue came into prominence early in the war. Long hours and Sunday labor were, at the outset, the natural response to the demands made upon the munition factories, with results disastrous to the workmen and disappointing to their employers. These experiences led to the formation of the Health of Munition Workers Committee; a parallel to which has been created in this country in the Committee on Industrial Fatigue of the Advisory Commission attached to the Council of National Defense. The American committee is associated with the Public Health Service. Both committees are scientific bodies and are now engaged in elaborate studies.

"Industrial medicine and sanitation," says Dr. Lee, "have been making marked headway; efficiency engineering, or scientific management, has devised methods that under proper direction have proved valuable; and no one can dispute the fact that these agencies have contributed a considerable share in making the human factor in industrialism more effective. But none has solved the problem (of maximum efficiency), and in recent years it has become gradually clearer that much light can here be derived from physiological science and that a new application of physiological principles—an industrial physiology, if one desires a specific title—has been gradually appearing."

The American committee has engaged the services of Mr. P. Sargant Florence, formerly connected with the British investigations, and under his directions studies have been made of the output of individual workers throughout the working shift. These show certain typical curves of production, analogous to the curves obtained in familiar laboratory experiments in the electrical stimulation of muscles, but far more complex. A common type of curve begins with a gradual rise of output (the so-called "practice effect"), followed by a gradual decline through the first working spell; after the lunch hour the general form of the curve is repeated. Monotonous work, frequently broken by natural pauses, may give nearly a straight line of production. A more or less conscious intervention of will on the part of the workman gives rise to remarkable departures from normal curves. This result is exemplified in what Mr. Florence calls the "stereotyping" of output, where the workman seems to limit his daily production arbitrarily to a certain "stint," even in cases where he is paid by the piece and not by the day.

It is interesting to learn that American war industries have profited by British experience, and have generally refrained from prolonging the hours of labor.

Electricity

Wireless Station at Guadeloupe.—It is announced that the new wireless station at Destrellan will go into operation sometime this month. Its equipment is sufficiently powerful to permit of communication with the most remote of the West Indian islands and with all vessels coming from Europe, the United States, or South America. It can also receive messages from the Eiffel Tower, but cannot send messages through to Paris direct. However, by using the intermediate stations of Dakar and Bizerte, the Guadeloupe plant will probably be able to forward radiograms to Paris. The Destrellan station is owned by the colonial government, but, it is said, will be open to the public.

An Oxygen-Filled Tungsten Lamp.—According to a recent German patent, beneficial results follow the burning of a tungsten filament in an atmosphere of oxygen at low pressure. This, it is claimed, prevents discharges through chlorine vapors evolved from anti-blackening materials introduced into the bulb. The oxygen at low pressure does not appreciably attack the incandescent tungsten filament, but in the colder regions of the lamp vaporized tungsten is oxidized to tungsten trioxide. The pressure of the oxygen present is, however, extremely low, being less than 0.005 mm. of mercury. The small amount of oxygen initially introduced into the lamp would be quickly used up, and the author therefore proposes to include within the bulb certain oxygen-yielding substances, such as the oxides, nitrates, chlorates, etc., of suitable metals. Manganese oxide in small quantities is found very beneficial.

Testing Arc Lights Under Pressure.—Wilhelm Matthiesen, a German electrical engineer, recently conducted a series of test with arc lights under different pressures of the two gases composing the atmosphere (oxygen and nitrogen). The first tests showed that the brilliancy of the light increases with increased pressure, while the specific consumption decreases, although the total amount of energy used is greater. The brilliancy itself, as well as the rate of increase, continues *Electrical World*, depends also upon the kind of salts mixed with the carbons. The second series of tests showed that the brilliancy of the arc can be increased by simply increasing the pressure of the gas, without increasing the consumption of energy. The rate of increase depends upon the gas used (air, oxygen or nitrogen). If calcium fluoride is mixed with the carbons and the resulting gases are permitted to accumulate, the brilliancy of the arc diminishes rapidly.

Electric Ship Propulsion.—A novel method of operating certain classes of overseas traffic is proposed by H. de M. Snell, which consists essentially in using one set of engines for a number of hulls. With the system proposed by Mr. Snell a set of Diesel engines for driving electric generators is fitted in a steel caisson, which also contains the engineer's quarters. This caisson is mounted detachably on the stern of any one of perhaps five hulls. These hulls are to be fitted with electric motors driving the screw but with no other propelling machinery. On arrival at port, continues *Engineering* of London, the whole caisson is to be lifted by pontoons from the hull of the incoming vessel and transferred to one about to depart. This operation can, it is claimed, be effected very rapidly by the use of special pontoons. As the machinery caisson is to be mounted on the stern of the hulls, the whole of the propelling machinery is confined to the after end of the boat. It is claimed that with this arrangement more effective subdivision of the vessel is possible, giving greater security against torpedo attack.

What's New in X-Rays?—At the meeting of the Röntgen Society, held on January 1st last, Mr. Carl Darnell read two papers, communicated by Dr. Coolidge of the research laboratories of a leading American manufacturer of electrical equipment. The first dealt with a new form of Coolidge tube, in which the anti-cathode consists of a block of copper faced with a small button of tungsten. This is fixed to a thick stem of copper, which passes out through the glass neck of the tube, and terminates in a fin radiator. The anti-cathode is thus kept cool, and does not in consequence emit electrons, as in the case of the earlier Coolidge tube, in which the whole of the anti-cathode speedily becomes red hot. The new tube, therefore, so completely rectifies current that when an alternating potential is applied only one phase of the current will pass. In the second paper by Dr. Coolidge and Mr. Moore, the portable or field X-ray outfit of the U. S. Army was described. A petrol electric unit supplies alternating current at 110 volts to a transformer arranged to give both high tension and heating currents for the new radiator type of Coolidge tube. For simplicity of control the tube is worked at a constant potential of five milliamperes for short periods. An electrically-actuated control on the throttle of the engine maintains constant output. The small size of the bulb, 3 ½ inches in diameter, enables a close-fitting lead-glass shield to be employed; this is made in two parts, and completely surrounds the tube, a suitable aperture permitting egress of the rays.

Science

How Does Coal Dust Explode?—According to the last annual report of the U. S. Bureau of Mines, opinions differ as to how flame spreads through a cloud of inflammable coal dust. Some investigators believe that the dust particles burn as a whole, while others hold that during the short period of heating, just before inflammation, combustible gases are distilled from the coal, and that these gases give rise to the explosion; thus coal dust explosions would be essentially the same as fire damp explosions. The Bureau has carried out experiments to determine whether any such distillation from the dust can occur. A dust cloud was subjected to momentary heating in air sufficient to cause inflammation. The same momentary heating was then applied to coal dust in an inert atmosphere of nitrogen, and the atmosphere was subsequently analyzed for combustible gases. These tests show practically no distillation of gas from the dust.

Submarine Valley Dangerous to Navigation.—The United States Coast and Geodetic Survey in its recent annual reports and some of its special publications has developed an interesting new type of Government document; devoted not, as such publications commonly are, to reporting on work done, but to setting forth in detail work that has not been done, but ought to be. Publication No. 48 deals with "The Neglected Waters of the Pacific Coast," and is a rather startling arrangement of official indifference to the accurate charting of the waters in question—a topic of timely importance, in view of the imminent expansion of our merchant shipping. A special feature of this publication is the information given concerning a little known submarine valley, which misleads navigators when taking soundings near Cape Mendocino. It has been responsible for several wrecks, including that of the steamer "Bear" in June, 1916, with a loss of six lives. The Survey has issued a new large-scale chart of the region containing this valley, though the available hydrographic data are admittedly inadequate.

Burbot and Bowfin.—These two hitherto neglected fishes have recently been rehabilitated through the efforts of the U. S. Bureau of Fisheries. The burbot is a fresh-water member of the cod family, and has a bad reputation as a destroyer of other fish. The Bureau secured the coöperation of some of the principal wholesale fish dealers at Great Lake ports in a campaign to put this fish on the market, with the result that about 500,000 pounds were marketed between April and June, 1917. The fish is generally sold skinned, eviscerated and headless, and furnishes a cheap food of good quality. Two years ago the Bureau began experiments in smoking various species of fresh-water fish at its Fairport station. One result of these experiments was the discovery that the bowfin, or grindle, heretofore regarded as practically worthless, yields a very superior product when properly smoked, indeed some who have tried it pronounce it the best of all smoked fish. The bowfin is generally known through the Mississippi Basin as the dogfish or grindle, and is abundant in the Great Lakes and in sluggish waters from Minnesota and New York to Florida and Texas.

Rock-Dust Barriers in Coal Mines.—The most important development of recent years in the study of coal mine explosions is the recognition of the fact that coal dust is a no less dangerous explosive than methane ("fire-damp"), and the search for methods of minimizing the danger from this source. There are two general methods of rendering coal dust non-explosive—first, by wetting the dust to prevent a cloud of dust from being formed, because only when the coal dust is in a cloud is it explosive; second, by adding to the coal dust enough incombustible dust to make the mixture non-explosive. The second method is comparatively new in the United States, but we have on previous occasions called attention to the efforts which the Bureau of Mines is making to bring it into more general use. The ideal practice is to apply a coating of rock dust to all the principal "entries" of the mine. Blowing machines have been devised for applying the dust, and a French instrument called the "volumeter" is used to determine the percentage of incombustible dust in a sample of mixed coal dust and rock dust. So long as rock dusting or watering is satisfactorily maintained, there should be no danger of an explosion being propagated throughout a mine; but if the method is not adequately maintained there should be supplementary means of preventing an explosion from spreading through a mine and perhaps killing everybody in it. Such means are found in "rock-dust barriers," originally devised in France, and developed in this country by Mr. G. S. Rice, of the Bureau of Mines. They are described in detail in the last annual report of the Bureau. These barriers are wooden troughs filled with rock dust, and set up in various places through the mine. When an explosion occurs the dust is automatically dumped from the troughs upon the floor of the mine, and the cloud of inert dust which fills the air at this point bars the passage of the flame in the burning coal dust.

Aeronautical

Canada as an Airplane Engine Producer.—A *Canadian Daily Record* telegram reports that the first 1,000 airplane engines which are being built in Toronto has been completed and tested with satisfactory results. The engines are being constructed at a plant worked by the Imperial Munitions Board.

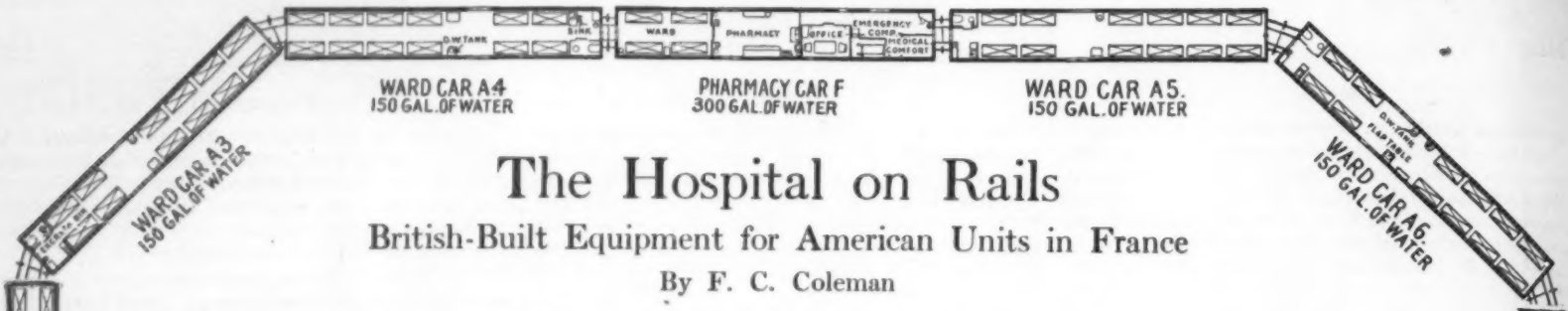
Why U-Boats Dread Seaplanes.—According to a semi-official German communique, a U-boat was recently pursued by two seaplanes in the English Channel from noon to evening, and was pelted with 23 water bombs. A few days later the same submarine, operating in the Irish sea, was hunted by several destroyers, which within a few minutes discharged 30 water bombs.

An Old Hun Trick.—In this war the enemy has made frequent use of poison candy and food which he has scattered by any convenient means in the interior of countries with which he is at war. The last case of this kind was a recent raid on Calais by German aviators, who dropped small packets bearing an inscription in English purporting their contents to be a powder for making soup. Analysis revealed, however, that they contained a violent poison.

German Strikes and Airplane Production.—The majority of British periodicals are inclined to regard the German strikes of recent occurrence as a form of political camouflage, or at least if the strikes are to be considered as bonafide, then the German ruling part is making the most of the situation, by circulating the news in neutral and enemy countries. "Mastery in the air," states *Flight*, "is the great watchword for our forces now and in the coming great 1918 offensive. Therefore let all our efforts in production be quadrupled, rather than eased off by reason of the fatuous camouflaged strike in the realms of the Hun, which according to the *Lokal-anzeiger* is still spreading in Berlin and the surrounding districts, it being specifically mentioned that the number of strikers at Johnasisthal aircraft works has increased from 1,500 to 1,900 and at the Albatros works from 218 to 697. A bit too thin for any effect here, we hope," concludes this comment.

Evolution of the German Fighting Airplanes.—"The demand for surpassing the ceiling [the greatest height attained by airplanes, or what is termed the *plafond*] of the enemy aircraft made it necessary to increase the area of the airplanes, this being, however, possible no further in the monoplane model," states a writer in the German publication *Deutsche Luftfahrer Zeitschrift*, writing on the subject of single-seater fighting airplanes. "Thus the small-dimensioned, light biplanes were produced, keeping the monoplane body, and here again Fokker turned out one of the most successful types, differing from the other fighting biplanes by obtaining lateral control through warping as against the ailerons of the others. The first Fokker biplane fighters had two sets of struts between the planes on each side of the body; but even though all parts were built light any small, our enemies, demanding no such high safetd figures as we, turned out fighting planes which were, owing to their smaller weight, equal to our aircraft, at times even surpassing them. This led to redesigning; when but one set of plane struts was employed. Thus the head resistance was also reduced, and the Fokker and Albatross, one-set strut biplanes, are still the most employed fighting airplanes. The competition with the airplanes of the enemies has forced German designers to shape all details in the fighting biplane to least weight and highest reduction in head resistance, the foremost result being the building of the engines into the bodies, while another result is the reduction of the rudder and elevator areas to a minimum, some designs doing away even with fixed tail planes and fins, as in the Haberstadt type."

Flight Without Wings.—Speaking recently before the Empire Club at Toronto, Canada, Prof. Alexander Graham Bell, the inventor of the telephone and one of the members of the Aerial Experimental Association which produced the "Silver Dart" many years ago, had the following to say regarding the airplane of the future: "The airplane is to be a deciding factor in this war. Men now fly 20,000 feet in the air, and what I want you to note is that theoretically the machine at that height should be more efficient by flying faster and more economically. Supposing your propeller has the same push at that height where the air is rarer, you should get more speed. "Dr. Bell then gave a scientific explanation of why the airplane should travel faster at the greater height. A change of gear, as in a motor car, which would make the propeller travel faster, he pointed out, was the solution of this problem, and he predicted the day when the flying machine would attain such speed that the wings may be unnecessary. "Now, if we have machines flying without wings, how about flying without engines?" added Mr. Bell. "All other things that fly, fly without engines. Consider the albatross, which, without the movement of its wings, can overtake a ship even when the bird is traveling against the wind. The flying of these birds is a problem open to science. The question is, 'How do they do it?'"



The Hospital on Rails

British-Built Equipment for American Units in France

By F. C. Coleman

SPECIAL cars devoted to special service, and which become laboratories, hospitals, offices, banks and hotels on wheels, are as old as efficient railroading. It is only within the past few years, however, that we have had the procedure extended to whole trains. Perhaps the first instance of this sort of thing was the trains operated by the Department of the Interior to advertise the land drawings. We recall the sensations with which, not many years ago, we beheld one of these drawn upon the siding at a nearby suburb, with a lecturer addressing a big crowd from the rear platform, and demonstrators conducting interested prospects through the cars and showing them the various exhibits calculated to make a man long for a homestead in Oklahoma.

Later the idea was put to a somewhat more dignified use—and if we must say it, a somewhat more legitimate one—in connection with rural improvement; railroads and state and federal governments cooperated in good roads trains and better crops trains and rural health trains and trains in connection with campaigns against insect pests, until the idea of the appropriated train had become a familiar one. At least one of our railroads installed a traveling materials-testing laboratory on this plan. Finally, with the outbreak of the war, staff trains and hospitals trains and various other types of special service trains have reached a high point of development.

The hospital train perhaps calls for a more elaborate outfit than any other. The very fact that its service is one extended to human beings, and of necessity is a continuous one, makes certain that it will at all times have a considerable human freight aside from the regular staff which never leaves it; hence living quarters must be on a scale not met with in other service trains. Likewise, there is such wide variety in the kinds of treatment which must be given that a very broad equipment must be carried. And while we in America yield first place to none in rolling stock design, the greater experience of our Allies in dealing with men who have been smashed up on the fighting front gives them a great advantage over us in knowing just what is needed and what is not. Accordingly we need find no occasion for surprise in the announcement that there has recently been completed in the shops of the Midland Railway of England a new ambulance train intended for the use of the American expeditionary force in France.

This train consists of 16 cars of one type or another—an infectious-ward car and nine ordinary ward cars, with proper distinctions between those for officers and for privates, a pharmacy car, a staff car and a personnel car in which the doctors and nurses have their quarters, a stores car, and two kitchen cars. In all there are accommodations for 430 staff workers and patients.

One of the ward cars, showing the three tiers of berths

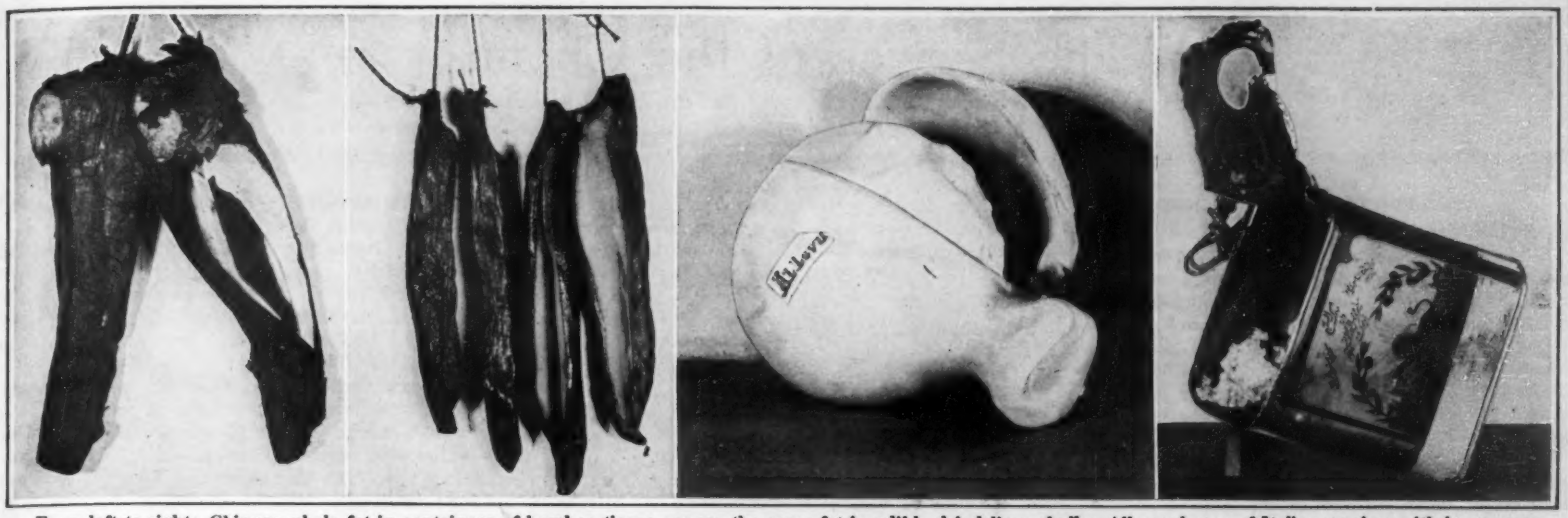
Interior view of the kitchen car

Sick officers' day saloon

As our cut shows, the ward cars are constructed on a vastly more economical plan than that employed in the ordinary sleeping car. There are the same six sections on each side of the car, but instead of but two berths in each section, as in the ordinary practice, there are three; so each car will provide space for 36 patients. The cots of the middle tier are arranged in such fashion that they can be folded down to form backs for sitting cases in the lower tier. The clearance between tiers, while not exactly generous, seems ample for all the demands of the situation; and on on the whole, the appointments of these "wards" seem decidedly up to the general hospital average.

A bath tub is an unusual feature of railroad trains, as the layman knows them; but it is obvious that a hospital train has got to have one. It is perhaps not so immediately obvious why this feature should be located in the kitchen car; but a moment's reflection upon the exigencies of hot-water supply will clear up this point. It may be pointed out here that one of the fundamental requirements of a good hospital is good water, and plenty of it; so no opportunity to store away the precious fluid above and below and in the out-of-the-way corners of these cars has been overlooked. In all, the train carries 2,635 gallons, wholly aside from the engine supply; every car has some, as a reference to the border diagram will show, and but two of them carry less than 150 gallons in their tanks. Surely every possible precaution has here been taken against drought.

The whole train is painted khaki color, with two large red crosses on white ground at either side of each car. It is vestibuled throughout, and every care has been taken to make possible the keeping clean of the interior—even to rounded corners between floors and walls, in which no dust can find lodgment to defy the efforts of the cleaner. The equipment of all cars—especially those like the pharmacy, designed for special and very technical uses—is admirably worked out in every detail, and on the whole we cannot but admire this British contribution to the medical outfitting of the American field forces.



From left to right: Chinese whole fat in containers of bamboo tissue-paper; the same fat in edible dried-liver shells; Alleva cheese of Italian armies, with inner core of butter; Turkish butter made from milk of the sheep, goat, buffalo, or mare

The Fats of Fighters

How Some of the World's Armies Get This Necessary Ration

By L. Lodian

FROM time to time there appears fragmentary comment in the papers upon the necessity of fats among the belligerents, but seldom or never is an attempt made to illustrate this important phase of an army's sustenance. It might be thought that there is nothing to illustrate about fats; but a glance at the pictures herewith will tell another story, although to be sure, much of the pictorial interest attaches to the containers.

Adequate fat supplies for armies have probably been a matter of attention ever since humanity started fighting in prehistoric times;' and the Asiatic hordes of Genghis Khan and Tamurlane carried earth-nut oil in bamboo sections, and cocoanut butter in containers of dried cocoanut, so that both butter and bowl were edible.

The problem of a sufficiency of metallic containers for the export of food supplies to our Allies has often been mooted in print. The present article with its illustrations may help relieve the situation, by throwing light upon some of the containers used all along the centuries by different armies, and making clear to our packers that such containers would be acceptable to the forces of diverse nationalities.

For example, take the illustrations of the bologna-form or sausage-skin lard holders. Although the Latin commissariats have bladders as well, they prefer the first-named alternatives, because they can be packed in boxes with greater saving of space, like big candles, by the hundred or gross; whereas the shape of the bladders entails a good deal of space wasted.

The pure horse-lard shortening of the French and Belgian armies, however, always goes forward in the horse bladder. Some of these weigh, when filled, from thirty to thirty-five pounds apiece. This horse-lard has an agreeable flavor, reminding one of the savory taste of cold bacon fat.

Even the Teuton commissariat has always had one unique fat container. The skin of the goose is removed seamlessly, one end tied up, and using the neck hole as a funnel, the goose-grease or lard is poured in, and the neck closed with a string. This makes a capital container.

The goat-fat shortening of the Greeks and Iberians is put up in small kilo casks, which, when empty, are used by the men as portable water-flasks. For the Persian and Turkish forces, the goat-fat is sent to the front in seamless rawhide skins of the sheep and the angora goat.

Millions of pig's feet annually go into the soup pot in America. But the Latins, who have been soldiering for milleniums, use the bigger ones for holding lard, butter, oil, or other fats for army use, as they are more resistant to wear than membrane containers like bladders or casing. These pig's feet, filled, have a provoking resemblance to sucking pigs. On this ground the Italians have nicknamed them porchinella, or little pigs; the hoofs, simulating the ears and front paws, add to the illusion. The feet are prepared for this use by machinery which rips the skin off like a glove, in a twinkling.

When their fat content is used up, the troops requisition the skins—if they can get hold of them—as a sort of seamless rawhide pouch for holding tobacco, coins, et al., or as a folding pocket water-flask.

The Parma and Gorgonzola cheeses are famed as macaroni and dessert cheeses; while the Alleva cheese illustrated is noted as the only type of the "two-in-one" cheese—cheese and butter combined. A ball of butter is covered with a thin envelop of cheese, the latter worked up in plastic form while slightly warm, around the chilled butter-ball. The covering gradually hardens, and, in drying, contracts, excluding all air. The butter is never salted, but can be thus preserved sweet for years. This ball butter is made by the million, and has been used in the armies of Italy since the days of old Rome. Every part is edible; there is no waste container to throw away or to conserve by converting it to some other use. By inserting a lighted wax vesta in the butter, Italian officers thus often extemporize a make-shift lamp.

The Mongols, like the Italians, put up an army fat for their forces in sausage casing, but they go them two better in also utilizing the strong bamboo fiber tissue-paper and thin sheets of dried liver as containers. We illustrate a batch of the latter duo. The liver is cut into thin sheets and wrapped around the fat. In drying, like the Italian cheese covering, it contracts, and keeps its contents air tight. The whole thing is edible, liver having *some* food value, the membrane none.

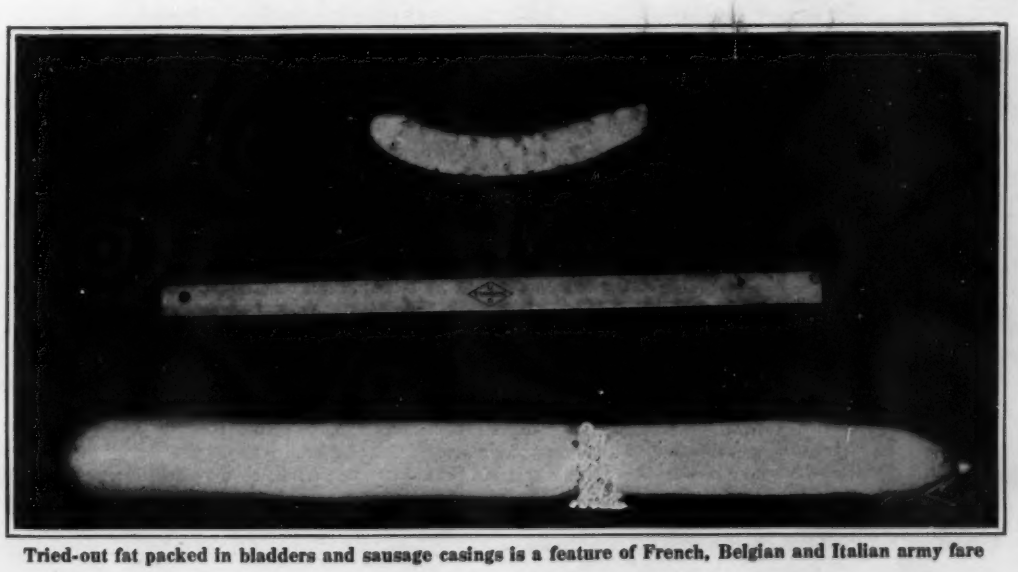
Tried-out lard also figures in the Mongol diet, being put up in the curious earthen crocks reinforced with strip bamboo. Again, their water-white rice oil is a most important addition to the officers' mess, being used for salads and the like. There is no olive oil in this part of the world, it may be said.

The ghee butter of the Turkish army is made from the cream from the milk of goats and sheep. It is always a boiled butter, granulated and unsalted, and can be kept free of rancidity for many years; cases are on record where it has been still edible after recovery from a couple centuries of seclusion in old castle keeps—though under such circumstances it has been found to be of slightly flat flavor. This ghee butter is the most important article of fat in the commissariat of all the Asiatic forces. Some of the Tartar tribes make it from mares' milk cream. It is a most sustaining butter, of somewhat tallowy taste, but many travelers get to like it.

The white chocolate of the Swiss army was noted in a previous paper as consisting chiefly of cacao butter fat.

This would seem to give a fair insight into some of the fats of armies. And there are more than double this number which might be illustrated and described.

Sow's foot filled with lard-fat, much used in the Italian army



Tried-out fat packed in bladders and sausage casings is a feature of French, Belgian and Italian army fare

Firebrick—New Researches

MESSRS. LE CHATELIER AND BOGITCH have been engaged in researches upon firebrick and the best makeup to be employed in order to secure the best results. Such firebrick is composed of granulated silica and various oxides in powder used as a binding material. They find that the best binding substance is impalpable quartz powder which is produced in special crushing mills. The use of this powder considerably increases the strength of the bricks at a high temperature of 1,600 degrees C., and this is one of the most important qualities of firebrick. Again, the proportion of 25 per cent of the powder gives much better results than 75 per cent, for when too much of it is employed the bricks all show small cracks after heating, which will of course become larger under a long heat. The best makeup for paste is one-quarter of impalpable quartz powder with grains about one-hundredth of a millimeter, and three-quarters of large quartz grains not above five millimeters in size.

The Service of the Chemist

A Department Devoted to Progress in the Field of Applied Chemistry

Conducted by H. E. HOWE, Chemical Engineer

Dry Foods for a "Dry" Country

A CONSIDERATION of the quantities of fruits, vegetables and other produce that fails to reach the market and a reminder of the transportation situation ought to be enough to indicate the increasing importance of research on drying methods as applied to foods.

One dry food that reaches a production of more than twenty million pounds annually is unfamiliar to practically all of our people. This is dry milk—a substance of such importance that it cannot be discussed in this space.

Campers, explorers and some others are familiar with dried eggs and quite a variety of dried vegetables, but most of the drying is done in the open air or in apparatus such as contributes to the despised dried apple pie. There are objections to a great deal of the dry food upon the market, some of it being discolored, some having a scorched taste and nearly all lacking in flavor.

Dehydrated material is a very different product and one which will certainly grow in popularity as increased population and changed economic conditions make it necessary to go farther away from the large centers of population for food supply. There are many intricate problems that must be solved in the laboratory before the ideal dehydrated food will be a reality. The moisture must be withdrawn at a temperature, under conditions of humidity, and at a rate that will not break down many of the cells, that will preserve the natural color and flavor and leave the food constituents unchanged chemically. When rehydrated, a fresh product suitable for cooking must result and not the leathery or soggy article already so familiar.

Much has been accomplished through the work of public-spirited citizens, manufacturers and chemists, but much remains to be done. It is a very large question of such importance that special bibliographies have been compiled and much study given to the economics involved in any commercial solution.

Before long we ought to avoid the losses attending the harvesting, transportation, storage and marketing of our food products. Successful dehydration—not mere drying—will accomplish this.

A Lesson from the Orient

IT would be of interest to hear what some of our farmers who refused to practice crop rotation would say when told that the idea which they scorn did not originate in their State Agricultural College but many, many years ago in China and that the conditions peculiar to that country, caused the Chinese to study animal husbandry, and determine how to use the available fodder to the best advantage. They learned that the food required to produce a pound of beef will make more mutton and approximately twice as much pork. They also learned the advantages of poultry to their country and notwithstanding a large population, eggs are perhaps cheaper there than anywhere else. This is attracting modern egg dehydrating plants from America.

Now we are studying another Oriental lesson. In the south are many acres where the boll weevil makes it impossible to continue the profitable production of cotton. The search for a substitute crop has introduced the soya bean from Manchuria where it is a very important staple and it bids fair to become most useful. The soya bean yields an oil upon hot pressing and just prior to the war, the Germans set up a naphtha solvent process in the Orient but the oil recovered was considered inferior to that from the native presses. The potentialities of soya bean oil have not been fully determined. It has become established in the industries and we are learning how to make better use of it as a food product. The oil cake or meal left after pressing is a valuable component of stock foods, being high in nitrogen compounds.

Some of the varieties of the soya bean are suitable for human food and in combination with peanuts, a foundation for several materials high in fat and protein is obtained. The soya bean alone comprises a ration that is nearly complete, for it contains a large amount of protein, fat in the form of oil and the starch furnishes a carbohydrate. The bean also carries a vitamine which is necessary to sustain and promote bodily growth but the mineral content is deficient.

One of our agricultural experiment stations is now carrying on researches, the object being to increase the percentage of mineral matter, for minerals have been shown to be one of the necessary factors in body building. A man has been described as seven or eight buckets of water and ten pounds of ash; the ash is composed of the mineral matter.

In the Orient soya beans are used to make a kind of cheese and a milk substitute. A peculiar cake is also made from them as well as a sort of fermented beverage.

Experiments are under way to improve greatly the food values in soya beans and increase the oil content. Bearing in mind the success which has attended the efforts to increase the purity and the sugar content of sugar beets, there is reason to expect success in this later work.

And so these cotton lands of the south which have so long contributed to our clothing may now greatly supplement our food supply.

Feminine Armor

WE often hear references made to those heavy silks worn by our maternal ancestors and laid aside without any danger of cracking. To produce a heavy bodied silk with satisfactory rustle approximately 5,000 tons of tin in the form of tin tetrachloride was used during 1917 in weighting silks for our American ladies. Doubtless the silks of yesterday can be readily duplicated but not at the price which the American woman has become accustomed to pay for a silk, and insisting upon a heavy silk at a price which does not permit that weight to be obtained by the use of silk fiber, she must clothe herself in a sort of armor. Some silks have carried as high as 300 per cent of metallic weighting, although that figure is not approached today. Probably a small amount of weighting may be used without detriment to the fabric and in the interests of metal conservation it may become necessary for the silk manufacturers to do without tin, even though most of his supply is obtained by the detinning of old cans.

Alcohol—A Large Chemical Family

THIS is not a prohibition argument for alcohol has many uses as well as misuses. It has been known from earliest history and by 1808 its quantitative chemical composition had been determined. Few substances have had such wide publicity.

To the average man alcohol means grain alcohol or the variety which is non-poisonous and found in a multitude of beverages the world over. Chemically the alcohols are a very large family, beginning with methyl or wood alcohol and extending through ethyl or the grain variety, propyl, butyl, and amyl alcohols to still more complex bodies. Some of these, like butyl alcohol, are by-products in chemical processes and uses for all that is produced have not yet been found. The economic utilization of butyl alcohol, obtained as a by-product in acetone manufacture by a fermentation process, constitutes one of the problems in the production of synthetic rubber on a commercial basis.

The alcohols of most concern are methyl, which is wood alcohol; ethyl, commonly called grain alcohol; and industrial, or denatured alcohol.

Methyl alcohol is obtained by the destructive distillation of wood without free access of air. From the decomposition of the cellulose, ligneous materials, sap, resins, etc., many products are recovered, some of which have little value. The alcohol is contained in the pyroligneous acid, which distills off at temperatures between 160 and 275 degrees C. and from this it is obtained, together with acetic acid and acetone, by purification methods. The yield of alcohol per cord of wood varies with different kinds of wood, yellow birch being among the most productive. Yields have reached 12 gallons per cord on a dry wood basis, and until recently only large pieces of wood were suitable for the retorts in use. A new method has now been perfected whereby wood waste may be employed with the same average results. This new retort is continuous in operation, both the feeding and discharging being automatic and self-sealing. The complex gas driven off is used to heat the retort.

A new process has recently been patented in Great Britain whereby methyl alcohol may be obtained by the reaction of hydrogen on carbon-monoxide or carbon-dioxide, when these gases are in the presence of such catalysts as platinum, platanized asbestos, copper, iron, chromium, nickel, uranium, vanadium, or their oxides. It is also said that this process may be employed without catalysts. The gases are passed in mixture through tubes or suitable vessels where temperatures up to 400 degrees C. are maintained and the alcohol is then condensed.

Ethyl alcohol, known as grain alcohol, spirits of wine, cologne spirits, etc., is obtained by fermentation methods using a great variety of raw materials composed of carbon, hydrogen and oxygen in the form of sugar, starch or cellulose. The sugars and starches must be brought to a readily fermentable state and care must be exercised to obtain the right yeast, the enzymes of which will produce alcohol and not those yeasts which produce acetic or lactic fermentations.

Some form of starch is the usual starting point, and the kind employed depends upon local economic conditions. In America corn, rye, and barley are used; in England, barley, rice, corn, and rye; in Germany, potatoes and beet molasses; in Sweden, waste sulfite pulp liquor, elsewhere molasses, fruit juices, sugar residues and similar materials. Bananas contain from twenty to twenty-five per cent by weight of fermentable materials and cassava with 30 per cent starch contains 87 per cent of fermentable substances calculated on a dry basis. Wheat, potatoes, yams, sorhgum, and corn stalks are other suitable materials.

Many interesting problems enter into the selection of raw materials as for example, the point at which it would pay to substitute potatoes for corn in American alcohol production. A bushel of corn produces approximately 2.7 gallons of 95 per cent alcohol and a bushel of potatoes containing 20 per cent of fermentable material will produce 6/7 of a gallon, so that when corn is selling at a $1.00 a bushel, potatoes must be available in large quantity at approximately 30 cents before they can compete. The potatoes used in Germany for alcohol production have been especially developed with regard to their starch content, without reference to their desirability as a table vegetable. Such potatoes have been known to contain as much as 30 per cent of starch, whereas our American potatoes seldom have more than 20 per cent but are of better flavor, finer texture, and are raised solely from the food standpoint. The average yield of potatoes raised for alcohol in Germany is more than two hundred bushels per acre normally valued at from twenty-seven to thirty cents per bushel.

Where corn is used the procedure is somewhat as follows. The grain after being degerminated is ground to a coarse meal and the meal digested for an hour or more with water under heat and pressure. It is then cooled and a proper amount of ground malt added and the mass thoroughly stirred. The temperature is regulated to keep the formation of dextrin as low as possible, while the starch is being converted by the diastase into fermentable sugar. The wort thus formed is run into wooden fermentation vats, suitable yeast added, and the temperature controlled so that as much of the sugar as possible may be rapidly converted into alcohol. Various methods to prevent the development of bacteria and the wild yeasts are employed, and undue frothing, caused by the carbon dioxide gas which is formed, is kept down by sprinkling oil or other substances on the surface.

When fermentation ceases from ten per cent to thirteen per cent of alcohol is to be found in the mash along with a variety of other substances from which it is separated by distillation. A number of distillations were formally required where a direct-fired still with a copper worm condenser was employed. Twenty-five per cent to twenty-eight per cent of alcohol resulted from the first run, starting with a 10 per cent mash. The second distillation raised this to 50 per cent and the third to 70 per cent. After many distillations 95 per cent was obtained but purer alcohol than that cannot be obtained by this method. By the use of more modern apparatus this concentration is now obtained in two distillations and moreover the operation is continuous.

Other raw materials make variations in this general treatment necessary, and the great demand for both industrial alcohol and the materials from which it is customarily made has inspired a large amount of research work of high order in the field of waste utilization for alcohol production. Low grade molasses has long been used for the purpose including beet residual molasses which is not suitable for human consumption. The liquor from sulfite pulp digesters contains the resins, gums, etc., from the wood and efforts to prevent the nuisance resulting when turning this liquor into the streams led to a method for its treatment for alcohol production. The lignin and gums are converted into fermentable sugars, yeast of a special kind is introduced and the resulting alcohol concentrated. The annual production of alcohol from this source in Sweden alone has passed the five-million-gallon mark and recent advices say that one plant operating the process in America is about to be greatly enlarged with Government coöperation and for Government account.

According to recent British patent, ethyl alcohol may also be obtained by the reaction of hydrogen on acetaldehyde, which may be made from acetylene gas by a contact process. The reaction takes place in the presence or absence of catalysts and under temperatures similar to those used in the production of methyl in a parallel synthetic manner. A suitable mixture of hydrogen and aldehyde is obtained by passing a current of hydrogen through the aldehyde. Perhaps the most

(Concluded on page 238)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

New Light On Our Eyes

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of January 12th, I notice an article entitled "New Light Upon Our Eyes" by Mary Dudderidge, which should be called a "Mirage." I have never seen so much misinformation in any single article, published by a scientific journal, as in this one.

There is no more imperfect sight at the age of 40 than at the age of 30 or 21. The concealing factor to the layman is the greater amount of nervous energy available in the individual. As the refractive condition of an eye does not materially change with the advance in years, careful examiners will find the same errors at 21 that they will find again at 40 or 50. Regarding perfect sight at 40, I wish to say that the standard set is rather an ideal, and that the person with a slight amount of myopia or hypermetropia can be considered normal for ordinary purposes. An exception to this takes place when there is general irritability or exhaustion of the nervous system.

Not a moderate degree of myopia but of hypermetropia is the natural adaptation.

Whatever Dr. Bates' discovery may be, the experiment performed on rabbit eyes is worthless, since they do not have binocular vision.

We were taught correctly in school that "the accommodation of the eye depends upon an alteration in the curvature of the crystalline lens," for every school boy can prove that to himself by observing the reflection from the light placed in front of the eye, as observed on the anterior and posterior surface of the lens during accommodation. The eyeball never was, nor will be, a perfect sphere, but is a segment of a sphere upon another sphere.

In myopia the "sphere" is not necessarily elongated, but the refractive power of the eye is increased.

In hypermetropia the eyeball is not necessarily too short, but the refractive power is insufficient. The aphakic eye, which is hypermetropic, is not necessarily too short.

It is true that a good many cases of myopia and hypermetropia are functional, but that does not alter the fundamentals.

The accommodation of fish eyes is effected through the ampulla Halleri, and the crystalline lens is a perfect sphere—not of lenticular shape as in the human.

The only animal that has eyes like our own is the monkey. Experiments in accommodation on eyes of the lower animals are useless for this reason.

Accommodation for near vision is not made by the oblique muscles, but by the ciliary muscles; the oblique muscles, however, are greatly concerned in convergence.

The image does not change on the sclera, or white of the eye, but on the retina.

The strain of the extrinsic muscles spoken of is only present in myopia. There can be no strain of the recti muscles to produce hypermetropia, since there is no such thing as negative strain.

The strain spoken of in connection with the desire to see a large surface clearly, is not strain of the eye, but psychic tension.

The savage has no better vision than civilized man; his apparent keenness of vision is due to training, the same as that of the sailor who can detect ships on the ocean sooner than the tourists.

H. E. SCHROEDER.

San Francisco, Cal.

[While "Dr." Schroeder is not a registered M.D., we take pleasure in publishing his letter, which is very representative of the attitude taken by many physicians toward Dr. Bates' work.

When an investigator announces that he has obtained results which seem to disprove accepted beliefs, and when he presents a full statement of these results and the things which they seem to prove, it is not a sufficient refutation of his work to point out that he has contradicted the existing theories. Dr. Bates knows that he contradicts existing theories; the SCIENTIFIC AMERICAN knows it; it was for this very reason that his work was given publicity through our columns. It is accordingly quite gratuitous for our correspondent to attack this work and this publication on that ground alone. If he wishes attention, he must support the current beliefs with some sort of argument or evidence, not merely reiterate them.

It may not be out of place to state, before going further, that Dr. Bates is an investigator of standing. On this point we need make no further statement than that, after having made known his preliminary results through the regular channels of medical publicity, he was invited to continue his studies at the Research Laboratory of the College of Physicians and Surgeons of Columbia University, and has been working under these auspices for the past six years.

We have not space for exhaustive comment on Dr. Schroeder's letter. In addition to the general remark that throughout his discussion he states as facts things that are merely presently accepted hypothesis or his own personal opinions, however, there are several points on which we must take issue with him.

Statistics of all observers contradict Dr. Schroeder in his assertion that the refractive condition of the eye does not change. In claiming that the observed deterioration of vision with age is to be explained on a wholly psychological basis Dr. Schroeder himself is doing precisely what he criticizes Dr. Bates for doing. He is attempting to explain an observed fact by means of a brand new and original hypothesis—and one which, we believe, has far less justification and far less prospect of general acceptance than the one which Dr. Bates has put forward to explain his facts. Moreover, to say that slight refractive errors are normal except when they cause nervous disorders is absurd—if they are normal they should not cause abnormalities, if they can cause abnormalities they are not normal.

Of course rabbits do not have binocular single vision, which is doubtless what Dr. Schroeder meant to say, since this is the correct designation for the way in which humans are able to see simultaneously with both eyes and thereby judge distances. But what of it? When a rabbit leaves off looking at a distant object and starts looking at a nearer one he has got to change the focus of his eye. One might as well insist that because a rabbit's eyes does not exude salt water when he is sad, his mode of accommodation for long and short vision does not accord with ours. Accommodation and binocularity are functions as distinct as are accommodation and weeping. And, too, Dr. Schroeder, as the eye and nerve specialist which his letterhead proclaims him to be, ought to know that a surprisingly lagre proportion of humans habitually fail to employ the binocular single vision which the structure of their eyes makes possible

If Dr. Bates is correct, we were not taught correctly at school; if we were so taught, Dr. Bates is wrong. But neither our school teachers nor Dr. Bates will be made wrong by merely calling the other right. We presume that Dr. Schroeder bases his statement upon the work of Helmholz. Now Helmholz was a very careful worker; and Dr. Schroeder may be surprised to learn that he never asserted that accommodation was effected by the lens. What he did say was that, so far as he could judge from the extremely unsatisfactory observations which were the best that he could get, accommodation seemed to be effected by the lens. He would certainly never have countenanced the bald statement of alleged fact into which this has been twisted by less careful successors, and to which his name has been attached. Dr. Bates spent two years studying photography in an effort to improve upon Helmholz's observations, and has succeeded in doing this; he has taken pictures of the reflection of light from the eye—something which Helmholz wanted to do and couldn't; and these pictures throw the weight of evidence against Helmholz's suggestion. Dr. Schroeder, by his silence on the point, implies that we did right not to publish any of these pictures until the series is complete to Dr. Bates' satisfaction, and until some at least of them have appeared in the medical press; other correspondents have not been so charitable, but have not moved us by their sarcasm. In addition to these pictures, Dr. Bates has shown cases of accommodation where the lens was completely absent.

We would refer Dr. Schroeder to the New York Medical Journal of May 8th, 1915, for experiments which prove that the action of the recti muscles shortens the eyeball.

We would state, in closing, that Dr. Schroeder's is not the only protest we have received from members of the medical fraternity—all men who write in perfectly good faith to point out what they consider as a case in which we have been imposed upon by the wily press agent, and had something "put over" on us. We wish to state right here that we would not think of publishing an article like "New Light on Our Eyes" without as thorough an investigation as we were competent to make. The result of this investigation led us to believe that Dr. Bates had new data which were at least susceptible of explanation in the way in which he explains them. Careful readers of our original article will realize that even Dr. Bates, himself, does not claim absolute finality in his findings; far less do we. Dr. Bates' own description of his work is that it constitutes an investigation which is still under way, and which appears to be leading to a new theory. As such it is of public interest; as such we published it, as such we still regard it.—ED.]

Another Point of View

To the Editor of the SCIENTIFIC AMERICAN:

. . . if you think it will add any interest to the controversy you may state that I did not write my article until I had demonstrated the truth of Dr. Bates' theories in my own person. When I went to him for treatment I could scarcely read the 30-line on the eye chart with one eye, and with the other I could not read more than the first three lines. The glasses I was wearing, prescribed by an eminent specialist, made it possible for me to do my work and relieved some of my discomfort, but they did not prevent me from having an almost continual pain in my weaker eye, and they did not check the progress of the myopia. I have now discarded my glasses; I can read all the letters in the chart with both eyes, and I have no more pain and no more discomfort, in spite of the fact that for months I have been using my eyes constantly—night and day, Sundays, Saturdays and holidays. I can hardly be expected to consider this a "mirage."

MARY DUDDERIDGE.

New York City.

A Hooverized Cake

To the Editor of the SCIENTIFIC AMERICAN:

May I put before the public through the columns of your paper the following receipe for a wheatless, sugarless, butterless, eggless and milkless war cake?

One cup of raisins, 1 cup of corn syrup, ½ cup of vegetable oil, 1 cup of water. Boil together 5 minutes when cool, add ½ teaspoonful of soda dissolved in 2 teaspoonfuls of boiling water, 1 cup of rice flour, ½ cup of rye flour, ½ cup of white corn meal, ½ teaspoonful of baking powder, 1 teaspoonful of salt, 1 teaspoonful of cinnamon, ½ teaspoonful of nutmeg, ¼ teaspoonful of cloves. Sift five times with flour and stir in mixture. Bake 50 to 60 minutes in moderate oven. This contains 55 per cent of protein, 80 per cent of carbohydrates and 54 per cent of fat, which amounts to 3,880 calories.

MRS. IDA MORGAN.

San Diego, Cal.

The Car of the Future

To the Editor of the SCIENTIFIC AMERICAN:

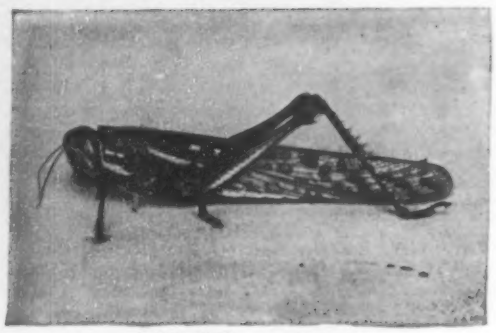
Allow me to submit a few considerations supplementary to C. H. Claudy's remarks in your issue of January 5th, 1918.

The design will probably more nearly approximate the form which is still being slowly evolved from the carriage body of a thousand years. Convention is very powerful and it is impossible to get away from it, so long as you have to market your product. Also, we cannot anticipate too rapid improvement of the roads. The unspoiled districts where the tourist will want to go will have rough roads for a long time yet; and these roughnesses will affect vehicle design. Probably the automobile of the future will provide for inequalities of the road by multiplying the number of wheels. Some trucks have multiple wheels at present with the aim to increase the traction surface. But the multiple wheels of the pleasure vehicle will have an entirely different motive. As long as a vehicle has two-point suspension, any disturbance of the plane of either point will inevitably be transmitted to the body of the vehicle. A spring, pneumatic tube, or shock absorber of any sort whatever, simply delays and distributes the readjustment that is inevitable when either point of suspension is moved from its plane. There can be no such thing as a joltless vehicle carried on two axles. But if three or more points of suspension are provided, the burden is distributed over so many points that one of them can be disturbed or even removed without harm; the remaining ones will still carry the load. The automobile of the future will probably be supported on as many as eight wheels, each an independent point of support with its own electric motor. Then the heavy car will glide smoothly along while the individual wheels clamber over inequalities of bad roads or the inevitable obstructions in good roads, such as car tracks, etc.

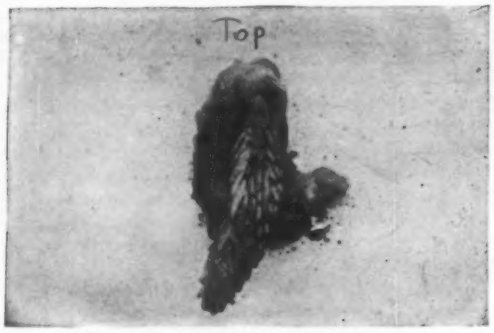
Inside the car, I will go a bit further than Mr. Claudy. The task of driving will indeed be the composition of a symphony on a keyboard of numerous stops that may be held by any occupant of the car on the knee. But the car of the future, of the sure-enough future, will be a *self-player*. A high-art chauffeur will have made a record of the trip and the strip of perforated paper will operate the mechanism that will push the necessary buttons on the keyboard. So the car will speed through the lowlands, linger along the heights; even *stop* for a particularly fine view; and off again, making detours on either side, as interest or beauty may suggest or rather have suggested to the original maker of the record. It is even possible that a synchronized victrola may interpret the landscape with appropriate music or wayside tale! A delicate arrangement of selenium cells will cause the machine to give half the track when another car comes into the field of vision along the high way or to halt promptly if an obstruction is met. Of course the tempo of this record may be varied at any time at the pleasure of the occupants of the car or the machine may be driven independently and the record again brought into play at any point.

KENT REMAY.

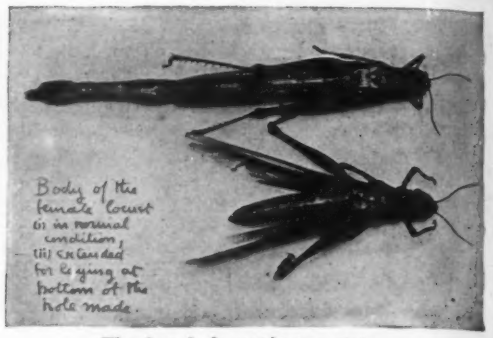
Jackson, Miss.



The full-grown locust



Mass of eggs laid by a single insect



The female locust in two states

Turning a Pest to Profit

How Uruguay Proposes to Make an Asset of Her Locust Invasions

A CURIOUS case of the conversion of an unmitigated nuisance into a source of revenue is reported from South America. It seems that in many parts of Argentine and Uruguay there have been for some years severe depredations by locusts. These do not by any means appear every year, nor are their visitations always destructive in the same measure; but this, while making agriculture in the long run alike possible and profitable, is scant solace to the individual farmer whose land is eaten over.

The locust is a curious beast. He spends the greater part of his career away from human habitations, in such uncultivated and even desert regions as are to be found in the Gran Chaco of northern Argentine, the vast wastes of central Australia, the desert plains of Africa, and, formerly, in our own unsettled west. Accordingly it is only in agricultural districts not far removed from such large vacant spaces that the locust pest is felt. Thus it was and is that in ancient Egypt and in modern South Africa, in Australia and in Argentine, the locust plague has been felt; thus it is that as soon as the unsettled land is occupied and put under cultivation the nuisance disappears, as from Kansas and western Canada. Eventually the same process would, of course, do away with these insect marauders in South America; but quicker action is naturally desired, if it be obtainable.

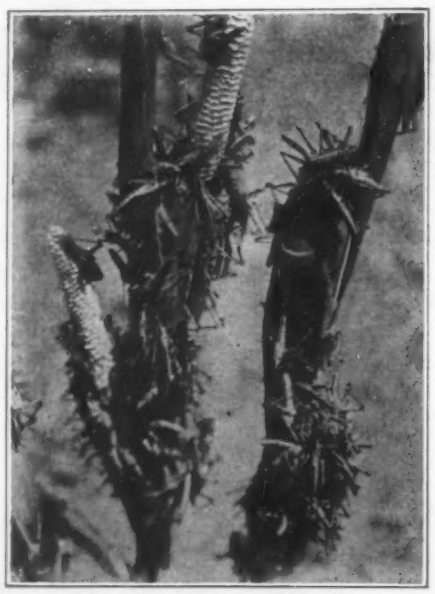
The invasions occur in connection with the business of reproduction. With the locust as with the salmon this function seems to be a gregarious one. When the season arrives the insects swarm, all together and in great numbers, to the fertile and cultivated regions which will be able to support the ravenous grubs. The invasion itself is not directly destructive; the creatures come, deposit their burden of eggs, and go away, eating little or nothing; their business at this time, as one writer has aptly put it, is not to eat.

There is no secrecy about the coming of the locusts. They travel high up and in a cloud, frequently many square miles in extent, which gives an odd purplish haze effect on the horizon. They stay for eight or nine days, roosting high on the trees at night and covering the ground during the daytime in huge, sluggish masses of industrious egg-layers. Then they are gone, leaving the seeds of trouble behind them.

In laying her store of eggs the female locust extends the posterior segments of her body to more than double their normal length. With the tool thus obtained she bores deeply into the ground and deposits from fifty to a hundred eggs, in general appearance and arrangement for all the world like a tiny bunch of bananas. She prefers bare spots for this work, and naturally she finds these in the roads above all other places; in fact, during the latter part of the drive, one cannot travel about without trampling the laying locusts in quantities. But neither this nor the effort to destroy the eggs in their hiding places by burning off the roads, etc., with oil, has any appreciable effect upon the numbers of the insects. The laying eggs and the locusts may be destroyed by the million; there will still be millions left. Once the laying swarm has come, there is the element of the inevitable about the situation. The vast hordes seem a graphic demonstration of the mathematician's concept of infinity as something from which any finite number may be subtracted without effecting reduction.

About a month after the layers have gone away begins the hatching out on the drive, as the South Americans call it. The young locusts go through six stages, and it is impossible to state in which of these they are the hungriest. In all stages but the last they progress by hopping, and the Argentine farmers know them as "saltonas" or hoppers. They do the most damage in the last of these saltona stages before becoming "voladoras" or fliers—not because they are any more voracious, but merely because they are larger. The big 1½-inch hoppers literally cover the entire country, marching in huge armies. They are so juicy that burning them, the only very hopeful means of defense, is practically out of the question. They eat everything in sight with few exceptions, reducing ripe corn fields to the merest stubble and trimming alfalfa as neatly and efficiently as a mower. They cover persons attacking them, they cover the sides of buildings, and when not all marching together they cover themselves in heaps. An English writer who witnessed a visitation of unusual violence in Argentine describes them in these graphic words:

A once handsome stand of corn after the locusts have passed



Locusts at work on corn cobs

"Beyond temporarily protecting the garden and fruit trees, so as to put off the evil day of destitution as long as possible—that is, until the locusts reach the voladora stage—the fight with them was quite useless in such a big invasion as this. Had we killed none, more would have died of starvation, that is all. In the earlier stages we could burn the locusts in some places—in the garden, on the roads, and in such paddocks as had degenerated back to the wiry and inflammable puna grass. In green alfalfa they had too much cover.

"About January 9th began the worst period of the plague, when large numbers of the saltonas had reached, and daily vaster numbers were reaching, their last and biggest stage before the final change into voladoras. It was now no longer a question of looking for swarms; they covered the whole country and marched in huge armies along the roads or across them from paddock to paddock. With their big impudent heads, ugly coloring, and caterpillar-like bodies, they were well adapted by their appearance to heighten the loathing which we all felt for them. They occupied our mental vision; we saw them in dreams; I see them still. We could now make them walk into pits, guiding them by barriers, but it made no difference. Flocks of hawks and eagles, seen at no other time, came literally by the hundreds and devoured, but it made no difference. They ate each other, they got drowned in drinking troughs and wells, we trod on them and beat them down with flails, they died for lack of food or were attacked by parasites, but it made no difference. If you stopped for a moment anywhere out of doors, you were soon covered with them—innumerable as the sands of the seas.

"Alfalfa was eaten to the ground, the leaves, bark and even the tender wood of the willow trees and acacias was devoured; they even attacked clothes. I saw one begin to eat, alive, a brother saltona that was changing its skin and therefore helpless, but I could not feel compassion for him. These new voladoras soon covered the ground and rose in short flights as one walked. They seemed anxious to eat, but there was little left for them. All February voladoras went away, and it is believed that they work around to the north and make for the Gran Chaco or other empty lands, wintering there.

"These locusts did not eat paraiso trees nor the tall native canes, nor onions, cucumbers, sweet melons, water melons, pumpkins, or certain flowers, nor were they very keen for the eucalyptus, unless ravenously hungry. In the invasion witnessed the locusts reached their full devouring power too

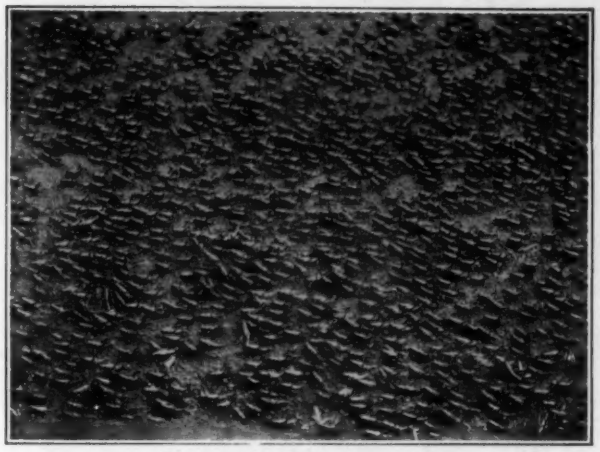
A collection of the tools used in fighting the invading hordes

Mass of locusts, caught at a barrier, being swept into pit for burning

late to eat the wheat and linseed, but where the crop was maize the result was ruinous. By careful planting with regard to an invasion hay in abundance may be saved, so that cattle are continuously fed, and once the swarms have passed, alfalfa, which they eat to the ground, soon springs up again."

Of course, it is not strictly true to say that killing these pests in quantities makes no difference. It makes no visible difference in the number left, to be sure; and there is some virtue in the argument that the ones left will always be sufficiently numerous to do a maximum of damage, and that accordingly the only result achieved by killing them is to save so many from death by starvation and give the rest more to eat per head. But a live locust eats and a dead one does not; and even more obvious than this is the effect upon subsequent invasions. For a dead locust will never become father or mother to a hundred hungry hoppers; so the burning and trampling and trapping in pits of the locusts does not represent labor wholly lost. Indeed, with improved measures and improved coöperation, and under government supervision, Argentine and Uruguay have made very encouraging progress along these lines.

Moreover, it has recently occurred to Senor Alexandro Otaegui, of Uruguay, to inquire into the chemical constitution of a dead locust, with the hope of discovering a way to make something out of him; and it develops that the troublesome insect consists quite largely of nitrogen and phosphoric acid. So Senor Otaegui has interested his government in a scheme for commercial utilization of the locusts which are trapped or destroyed. If it is possible to bring these plans to a working basis, a notable stimulus will be given to the work of trapping the locust, and we shall have another interesting chapter in industrial chemistry. Soap and fertilizer and lubricating oils as a by-product of a locust invasion furnish a broad field for speculation, some of which may indeed be humorous, but much of which will turn out to be serious enough.



The march of the "hoppers"

A Tree-Felling Machine

ALMOST ingenious and useful little machine was recently tested in the Grunewald forest before representatives of the Forest Department, the City of Berlin, etc. It was a handy motor saw designed to fell in a minimum of time the very thickest trees. Not only does it saves time and labor, but wood as well. The machine will cut clean through a trunk 30 inches in diameter in a couple of minutes and split it in bits on the spot.

The machine is made up of two parts, the motor and the saw proper. The motor, about ninety pounds in weight, has an output of five horse-power; it is air cooled and the fact that it does not require any water for cooling is an especial advantage in winter. The noise of the motor is reduced to a minimum by a muffler. The motor further comprises a safety device against the risk of fire, so that the exhaust flame will not endanger the forest. Gasoline or benzol is used as fuel. The fuel consumption with 10 hours working is little more than half a quart. The machine is, however, eventually to be designed with electro-motor drive, which is thought to afford advantages in a number of cases.

The saw proper is designed in three sizes, for trees 80, 60 and 40 centimeters (31.5, 23.6, 15.7 inches) in maximum diameter. It is a chain saw with links of six teeth each, which are readily exchanged. The saw runs in a frame over four rollers with ball bearings, one of which is set in motion by a flexible conical pinion shaft. The hollow handle is designed as a reservoir for oil.

How Big is the Browning Machine Gun?

THE nature of the illustration of the Browning machine gun appearing in last week's issue gave no idea of tne size of our latest weapon. For that reason the accompanying illustration of the latest machine gun is of interest, showing, as it does, its small size. In this particular case a heavy tripod is shown. This and other photographs of the Browning machine gun indicate that aside from the light-weight tripod presumably intended as the standard equipment, the gun will be furnished also with heavy tripods for permanent installations as well as the quadrant type tripod for use against aircraft. With the possible exception of the Colt weapon, the Browning appears by all means to be the smallest machine gun in successful use.

Browning machine gun being examined by interested American and British officers

War Aids Psychology

A BRANCH of science for the development of which the war affords rare opportunities is psychology, for it will enable investigators to observe and study the human mind under most varied and unusual conditions such as could but rarely occur in ordinary life, and then in single isolated cases. One of these conditions is shell shock, the results of which are most intricate and interesting, and the study of which is of great importance. In an article in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT the writer says: "In a general way emotion is a reaction of the personality. Under intense emotional shock an individual may be deprived of even elementary perceptions; not seeing any more, not hearing any more, not feeling any more, transformed into a simple automaton, the subject is, so to speak, in a state of physchological syncope. Soldiers under shell fire may become for the time being mere automata, and wander away unconscious of what they have been doing; it is difficult to decide whether they are suffering from emotional shock or from commotional shock without visible injury caused by forces generated by high explosives." One of the results of such shocks is dreams, and it is the psychology of soldiers' dreams that is particularly dealt with in the paper on "War Psycho-Neurosis" referred to above. The author gives a most interesting discussion of the nature and effects of these dreams, with a wealth of verified examples drawn from the experience of soldiers in the trenches.

Diamond Fields of Dutch Borneo

INTERESTED persons in Holland are directing attention to the diamond fields of Dutch Borneo, which, while known of for centuries, have never been developed notwithstanding the Netherlands has in Amsterdam the greatest diamond-cutting industry in the world.

Interest in this subject has been aroused most particularly by reports that diamond mills are to be established at Birmingham, England, as soon as the war ends, and that British (African) rough diamonds (on which the Amsterdam industry is now entirely dependent) are to be diverted to their use. This is construed to mean that the Dutch mills can have only such British rough diamonds as may remain after the British mills are supplied. Apparent confirmation is found in quotations from alleged official British statements that crippled soldiers are already learning diamond cutting, and that in a short time a body of fully 2,000 diamond workers will be formed in England (a fifth of the number in Amsterdam, of whom nearly a third are now unemployed). It is supposed that refugee diamond workers from Antwerp will form the nucleus of this body.

These reports create concern sufficient to induce an appeal to the Dutch Government in regard to the undeveloped Borneo diamond mines. In fact, it is stated that two years ago the government was urged to take action in this matter, and that it promised to do so. What action has been taken is not yet announced. No details of the possibilities in Borneo are made public, if known, except the statement of the most experienced man in the Amsterdam diamond industry that energetic development of the Borneo fields would yield important quantities of diamonds. Holland is now wholly dependent upon the British diamond mines.

Demonstrating the tree-felling chain saw

The chain saw mounted in its roller frame

Concerning Fuel

Silks For Fire Wood and Diamonds For Coal

By A. C. Laut

SILKS for fire wood and diamonds for coal!

We haven't quite come to that this winter, though many people would gladly have exchanged their silks for fire wood and their diamonds—if they had any—for coal; but for ten years the greatest heat engineers in the world have been warning us that is exactly what our heating system in America resembled, and some day in stress of war or cold, we would pay for our stupidity—and pay we have for three of the bitterest months ever known in America.

Small comfort it is for the East shivering in wintery blasts without coal to know that there is a section in the Middle West of 2,000,000 families, or 5,000,000 people, using natural gas for fuel, light and heat at the trifling total cost per year of only $35 a family. Yet for a decade the big scientists have been telling us we were fools to depend on coal and wood for heat in the great congested cities, where 50 per cent of the heat value goes up the chimney, where we have to haul 100 per cent of ash and waste on overloaded railroads through overcrowded streets, with all the duplication of useless wages for work before burning, and work after burning. What we should be doing is turning on gas or electricity for heat, and saving the by-products of coal and wood to run our battleships, supply fuel to our merchant ships, and motor power to auto car and the huge fleets of coming airplanes. Think of the Middle West able to turn on heat and light at a cost of $35 a family for such a winter as we have had! Then think of the Atlantic Coast cities unable to get coal fuel at any price! All because we have been heedlessly stupid.

When Henry Doherty, the great gas engineer, was in London a few years ago, he was asked by some brother scientists, if he knew of any way to abate the fog nuisance of London, which is really the result of gas from soft coal fuel. "Yes," he answered, "dig four feet under the surface of your streets. Let me wash all the benzol out of your gas mains, and I'll supply you an odorless, colorless, gas fuel, and at the same time save you enough motor fuel from your gas and coal to run every battleship in the Empire and every motor car in the United Kingdom." What sense—Doherty asked—to cumber up any great congested city with such bulk fuels as coal and wood? For every ton of coal carbonized, from one to two gallons of benzol were wasted; for the benzol must be scrubbed out of the gas. Benzol for heat purposes at 60 cents a gallon was equivalent to coal at $100 a ton, or New York gas at $24 per 1,000 cubic feet. Our fuel practices were an economic crime, about as sensible as silk for fire wood, or diamonds for charcoal. The scientist says: "Take those valuable ingredients out of gas and coal, and let the public use a fuel that is pure undiluted heat only."

The scientists of London gasped. "Too daring, Doherty! Too daring!" That would mean changing all gas standards from candle power—or luminous tests—to heat units as a basis of sale, which is the entire tendency in America today.

Why insist on a lighting standard in gas used almost exclusively for heating, especially when the lighting qualities blacken the bottom of the kettle, and add greatly to the cost? New York State and a few other states and the Federal Bureau of Standards have seen the point and changed legal standards. New York in 1916 fixed heat units instead of candle power as the standard value for gas. The candle power standard decrees that a certain amount of light shall result from the burning of so many cubic feet of gas per hour in an open burner, equivalent to the burning of a certain number of a certain size candle. Now New York gas must average 585 heat units per cubic foot instead of sixteen to twenty candle power. To maintain the lighting standard which is unneeded, the gas has to be enriched by expensive oils; and the increased cost falls on the consumer. Or take the great North-West. Cheap by-products of sawdust, stumpage and other wood waste, of inferior coals etc.,—could be used to manufacture gas with an equally useful heat content in these sections if it were not for the ridiculous standards; but because double standards are demanded for gas, expensive bituminous coals have to be hauled across the continent; and the ultimate excess cost falls on—not the company—but the consumer. In terms of dollars and cents, the consumer is paying a dollar plus for his gas owing to these useless standards, when he might just as well be paying very much less and getting very much more and much better gas.

Another point, in the early days of gas for heat and power, we in the West used to pay $3 a thousand. As the price declined the use increased until a price of one dollar was reached. At this price the use in many localities has quadrupled. What the scientists ask themselves is this—suppose we could reduce the price so that the use of gas fuel became general? Would not small profits from multitudes of users aggregate bigger profits to the company than high profits from fewer users? Think what the accomplishment of this thought means to the civilized world. Gas for all domestic heat in the hamlet and on the farm as well as in the cities.

Conservationists sometimes worry about the oil supply for the world's navies and merchant fleets. Every time the British fleet goes to sea it uses up 350,000 barrels of oil. How can the oil fields of the world stand this drainage? The fuel engineer smiles. He knows that the waste products of gas, the very ingredients that have to be scrubbed out of it, would run every battleship and motor car in the world. Before the War, we used coke for steel and iron processes. Since the War, from the by-products of coke we have saved tar, ammonia, benzol, tuloil, nitrates and the basic crystals of dyes.

If all this saving of waste could be accomplished by simple changes of standards in fuel, why not change the standards? Because there are 49 different states with 49 different standards more or less, though the Federal Bureau of Standards has put on record in guarded terms the great need for change. Here are several excerpts from one report of the Bureau: "Gas engineers are almost unanimous in favor of heat value as against candle power." "Heating value is superior to candle power in gas standards." "The standard which enables one to get the largest number of heat units from each pound of coal or gallon of oil is the best one." "The gas which gives the most thermal units to the customer for a dollar is the best." This section ignores the fact that if all standards were abolished and gas sold by the number of heat units delivered the customer could be given most

(Concluded on page 240)

What Machinery Means

By How Much Does It Increase the Productive Capacity of the Worker?

By J. M. Bird

THE course of events for the past 150 years has revolved largely about the phenomenon which the historian knows as the Industrial Revolution. The results of this movement have been of tremendous consequence, felt throughout our social and economic fabric. But in the last analysis they all come back to the common cause that, with machinery and power, a worker is many times more effective than without. This is the fundamental fact that has shaped the world's history for a century and a half.

The results from this cause, complex as they are, have been sufficiently tracked down and written about. But there is a surprising tendency on the part of our historians to state the cause about as I have stated it, and to let it go at that. This is not satisfactory; we should at least try to find a numerical measure of the machine worker's productive superiority over the hand worker. As far as I can discover, the only place in which this effort has been seriously made is in Carroll D. Wright's "Industrial Evolution of the United States." But the treatment here is far from complete. It is not sufficient merely to state the factor of comparison for various trades and operations. In order that we may secure an intelligent perspective of our field, it is necessary to bring to bear upon it intelligent principles of classification; and these by no means always follow the lines along which our industrial organization is divided into industries and trades.

The type of machine possessing the greatest labor-saving potentialities is the multiple-unit one. Here each unit replaces a single hand worker, and the units are so combined that many of them are handled from a single control by a single operator. The units may work faster than a man, but this is an incident; the inherent advantage lies in the fact that here we have actual multiplication of the operative's hands.

Doing Twelve Thousand Things at Once

The performance of this type of machine varies widely. The example par excellence is the spinning mule. Here one girl, in charge of several thousand spindles, will turn out from ten to twelve thousand times as much cotton yarn as her grandmother's grandmother could produce on the spinning wheel with its single spindle. For one type of mule, the exact figures are 820,000 yards per hour against 75.

Knitting and weaving machines operating on the same multiplicative principle are not so effective, because the units require more attention from the operator, who accordingly cannot care for so many of them. Even so, the ordinary power loom increases the individual output from 40 yards per week, to well above three thousand—a factor of 75 and more; and the most up to date stocking machine does at least two thousand times as much as the knitter by hand. On heavy, close work, like carpets, multiple unit spinning and weaving require so much more of the operator's attention that the one gives a factor of at most one hundred, the other of no more than ten.

While the multiple unit machine is in wide use outside the textile industries, I have space for but one more typical case. This is the ruling machine, in which, instead of a single pen drawn again and again across the sheet, we have a whole battery of pens passing once over to produce all the lines required. For ruling of average complexity the old way proceeds at a rate of about twelve double sheets an hour; the machine rules 1,750 single sheets in this time, giving a factor of comparison of about seventy-five. Outside the light spinning operations in which the operator can multiply his work by thousands, a figure of from seventy-five to one hundred seems to represent a very fair general average for the productive factor of the multiple-unit machine.

Doing One Thing, But Doing It Quickly

A second fundamental type of machine is the single unit one, requiring an operator for each unit. Here the economy depends solely upon the speeding up of the work, and can approach that attained by a multiple-unit machine only when the hand operation proceeds at an extremely slow rate. If the textile industries are beyond all comparison those of the multiple unit, it is in the book and magazine factory that we find most consistent reliance placed in the single unit mechanism. The linotype is such a machine; it does the work of from four to eight hand compositors, with six as a fair average. The flat-bed book and magazine press is another such machine, and one making an extraordinary showing for this type, since few hand operations are so tedious as printing.

On the old Ben Franklin press, requiring inking, insertion of the paper, screwing down and screwing up again, and removal of the sheet, it was hardly possible to strike off more than thirty impressions per hour, of four pages each. The latest flat-bed press has a practical capacity of 1,400 impressions per hour. Printing 16 pages at each stroke, we get here 22,400 pages per hour, against 120 by hand. Under union conditions three men are required for two presses; so, in practice, we get a factor here of 120. But an automatic feeder is now on the market which makes it easily possible, as far as the machinery itself is concerned, for one man to run two presses. On this ground, without reference to extrinsic restrictions, it will be seen that printing machinery is capable of multiplying the book printer's capacity by 360.

When we get into the bindery we return to the single figures characteristic of the single-unit machine. The gathering machine, mimicing to an extraordinary degree the motions of a girl doing the same work, collects the pages of five volumes while the girl is doing one. Case making machinery does a rather complicated job of cutting, fitting and pasting, and so shows a factor of at least ten. The casing machine which puts the book in its jacket again imitates closely the hand worker's technique in attaining a factor of somewhat less than three—I have seen two men turn out 3,540 cased volumes on the machine while two others, across the aisle, were casing 1,320 copies of the same book by hand.

While these examples are thoroughly representative, I may add a few more from other trades. A first class penman should turn out about one thousand six hundred words per hour; the expert typist will not exceed four times this speed for any considerable time. For the

(Continued on page 240)

Doing Away With the Arc

How the Incandescent Lamp and Optical System Were Developed for Motion-Picture Projection

By R. P. Burrows and J. T. Caldwell

UP to the past year, application of incandescent lamps for motion-picture projection had been confined to small portable and home motion-picture machines using the regular nitrogen-filled stereopticon lamps of the 110-125 volt class. However, after two years of experimental work an incandescent lamp has been developed which can be used for motion-picture theaters projecting a picture not over 12 feet wide on a plain white matt or muslin screen, and not over 13 to 14 feet wide on a selective or metallic screen with a "throw" not exceeding 90 feet. This result has been obtained by the construction of a special lamp which has been designed to be used in conjunction with special condensers and spherical mirrors, and if so used will give the proper results.

In the past the source of light most widely used for light projection in motion-picture machines has been the arc; results have been accomplished due mainly to the high brilliancy of the arc and less to the efficiency with which the light is utilized. When using incandescent lamps, however, it is necessary to work with a light source limited to approximately one-fourth of the brilliancy of the positive crater of the direct-current arc; consequently, the success with which the incandescent lamp meets will depend upon the utilization of the light. Thus it can readily be seen that to obtain successful results special condensing systems had to be developed utilizing a much greater angle of light than that utilized from the arc with the present plano-convex condensers.

In the study of an optical projection system, it is necessary to consider the system in the three individual parts and then all collectively. These parts are, (1) The source of light including the spherical mirror, (2) The condensing lenses and (3) The projection or objective lenses.

The action of the optical system is as follows: The spherical mirror used in conjunction with the lamp utilizes the light given off from the rear surface of the lamp filament, redirecting this light to the condenser; thus the light utilized from the bare lamp is greatly increased by the use of the spherical mirror. The condenser gathers the rays of light from the light source, directing it through the film (or slide) to the projection lens which enlarges the object on the screen. Fig. 1 shows the complete optical system as arranged for motion-picture projection.

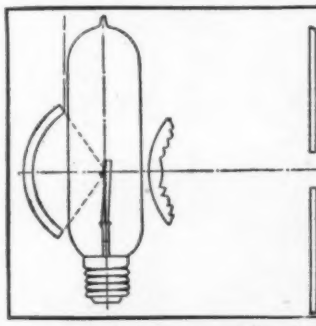


Fig. 1. Optical system employed with gas-filled incandescent lamp

In designing these lamps, it is necessary to take into consideration the following points:

1. The intrinsic brilliancy, that is, the candle power per square inch of filament surface, is limited by the life of the filament and the diameter of the filament. In general, the greater the diameter of the filament, the higher the temperature at which the filament may be operated for the same life and, the higher the temperature, the shorter the life but the greater the candle power emitted per unit of area.

2. The size of source is limited by the optical system, and the light given off by that portion of the light source falling outside of the dimension of the light source utilized by the optical system, is utilized much more inefficiently than that portion falling inside of the required dimension.

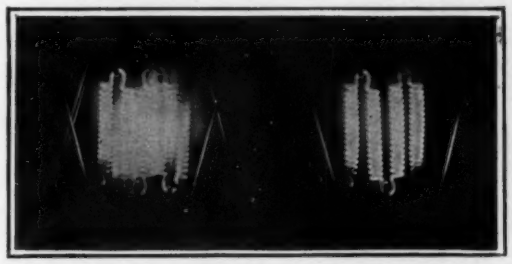
3. The distribution of the light is governed by the construction of the source; therefore, it is necessary to have a construction which permits of a distribution of light most efficiently used within the angles utilized by the condenser and mirror.

4. The wattage of the lamp is limited, first, by the size of light source, second, by the construction of the light source, and third, by the diameter of the filament.

It will be readily seen that the diameter of the bulb must be as small as possible in order to gain the advantage of a short rear focus condensing lens. However, if the bulb can be made long and yet small in diameter, that is, tubular, the necessary volume can be obtained within the bulb. Thus, the small diameter, tubular bulbs are the most desirable for motion-picture projection because they permit the use of short rear focus condensers.

Furthermore, it is necessary to concentrate as large a wattage as possible in the size of source utilized by the optical system. This can be most easily accomplished by the use of a large diameter wire or, in other words, through the use of a high-current, low-voltage lamp. With such a lamp, the high brilliancy of source is obtained by operating the filament at a higher temperature than for low current lamps.

The new motion-picture incandescent lamp is shown in Fig. 3. The filament is wound in the form of four helical coils lying in the same plane and so arranged that the distance between the coils is equal to slightly more than one-half the diameter of the coil. The spaces between the coils are filled with an image of the coil by the use of a spherical mirror. The lamp has a maximum over-all length of 10 inches with a light-center length—the distance from the extremity of the base to the center of the light source—of 4¾ inches. The lamp is made for tip-up burning. The bulb is tubular and is 2½ inches in diameter and has a mogul screw base. The lamp is rated at 20 amperes at 28-30 volts, with an average life of 100 hours; it is designed for operation on circuits regulated for current rather than for voltage.



Figs. 6 and 7, respectively, showing filament coils with mirror and without mirror

The monoplane filament construction (the four coils are in one plane) permits the best utilization of the rays of light by the lens and mirror system. As stated earlier in this article, the spherical mirror, Fig. 4, gathers the light from the rear portion of the filament and redirects it into the useful source. The action of the spherical mirror in placing an image of the coils between the coils and thus giving a smooth field is shown in Fig. 5. Although the monoplane construction is used in this lamp, it should not be thought that this construction is the best for all kinds of work. The renewal cost of a lamp on the basis of 100 hours lamp life is comparable to the present average cost of carbons, especially where the lamps are used to replace carbon arcs in motion-picture theaters with a long period of burning each day. The reduction in the wattage by the use of incandescent lamps with the properly designed lens system permits a considerable saving over the present arc lamp in view of the fact that the wattage of the incandescent lamp is only 600 watts as compared to arc wattages in the order of 2,500 watts. The new light works equally on alternating or direct current circuits.

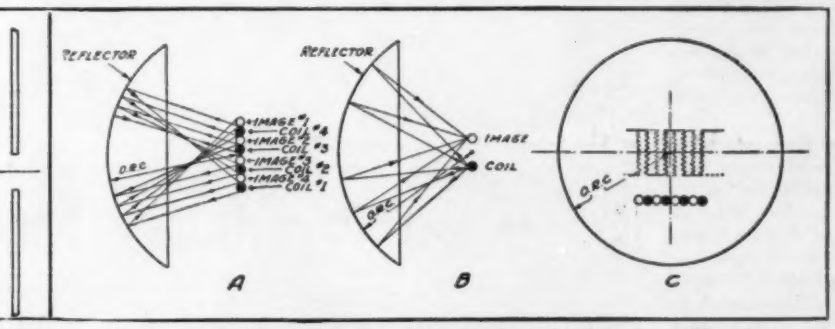


Fig. 5. Sketch illustrating the action of spherical mirror in making the light source appear solid

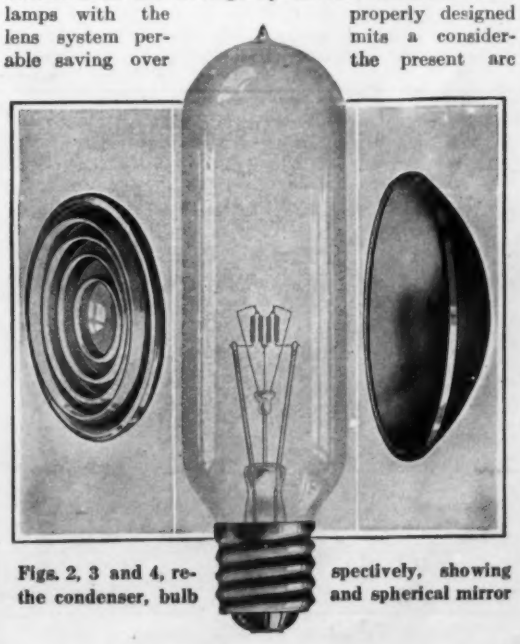
As previously stated, it was necessary to design a short rear focus condensing lens to utilize a maximum of the light generated by the lamp. The condenser shown in Fig. 2 is a prismatic lens of the Fresnal type, and it eliminates the difficulties encountered with an extremely short rear focus plano convex condensing system. The condenser utilizes a solid angle of 76 degrees as compared with an angle of 40 to 50 degrees from the arc lamp condenser. The prisms have been so designed as to give a thin lens and yet to distribute the light uniformly over the screen. The lens is 3½ inches in diameter with foci of 2 inches to 5 inches. The condenser should be placed as shown in Fig. 1 with the prisms facing the aperture plate. This prismatic condenser is the most efficient condenser which can be used with the incandescent lamp at the present time.

The mirror, Fig. 4, is 4½ inches in diameter, has an outside radius of curvature of 2¾ inches with an approximate focal length of 1 11/16 inches, and utilizes an angle of approximately 110 degrees. A high temperature backing is used on the mirror to withstand the extremely high temperature encountered. The filament of the lamp should be operated at the outside radius of curvature of the mirror. The mirror as specified will increase the illumination obtained on the screen from the new lamp by approximately 75 per cent.

The illumination from the incandescent lamp on the screen is very uniform—there is neither travel of the light source nor source flicker as in the case of the arc. The color values of the light from the incandescent lamp are good. The new lamp is entirely enclosed in a metallic housing and the heat is confined, which permits the booth to remain comparatively cool. The trouble of carbon dust deposits on the condensing lens is eliminated. The reduction in operating expenses has been previously mentioned; the average renewal cost is slightly lower and the wattage consumed is much less. There is a further saving in the elimination of the warming-up process of the arc with its requirement of overload capacity. The simplicity of the incandescent lamp is a feature which appeals to the operator. Once the lamp is placed in the projection machine, it requires no further attention from the operator until it burns out.

The incandescent lamp for motion-picture projection when used with good regulating equipment and in connection with the proper mirror and special condensing lens will, in general, replace nearly all alternating-current arcs, and any direct-current arc up to 35 amperes. The size of picture which can be projected has been stated in the introduction. Too much stress cannot be placed on the use of the mirror and condenser recommended. Further development in the way of shutters and projection lenses will, no doubt, increase the field for the incandescent lamp.

At the present time there are in the neighborhood of 300 theaters using the 20 ampere, 28 to 30 volt incandescent lamp with the equipment recommended and giving satisfactory service projecting pictures of the size and with the throws specified.



Figs. 2, 3 and 4, respectively, showing the condenser, bulb and spherical mirror

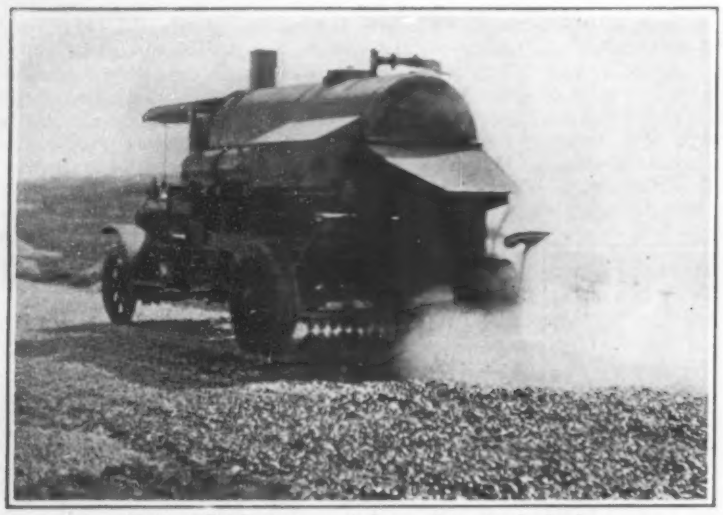
Paper Horseshoes

AN EUROPEAN inventor proposes to make a paper horseshoe that shall for general purposes be the equal of the steel horseshoe, in the following way. Parchment paper is cut out in horseshoe form and built up to a suitable thickness by the use of a mixture of turpentine, Spanish white shellac and linseed oil treated with litharge, and the whole is placed under the hydraulic press. This produces very light and uniform pieces, and it is an easy matter to stamp out the nail holes and grooves. Instead of nailing to the horses hoof, they can be applied with an adhesive composition whose principal part is a solution of rubber in bisulfide of carbon. Paper paste could also be molded into the shape of a horseshoe by use of the press, but the result is not as good as with the above. Among objections to it are these: the surface is too even and slippery and the shoe would not hold well on the ground

The Motor-Driven Commercial Vehicle

Conducted by VICTOR W. PAGÉ, M. S. A. E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles



Hot tar distributor mounted on a 5-ton truck chasis

Military road under construction in Government reservation

Expediting Construction Work at Army Cantonments with Motor Trucks

THE usefulness and general adaptability of the modern motor truck is now so well recognized that the most phenomenal performances in motor transport are accepted as a matter of course and given but passing mention. While motor trucks have done remarkable work in important capacities behind the battle lines, there is no achievement that surpasses the work done in this country to enable the contractors to finish the large army cantonments in record time, during a period when transportation by rail was none too reliable and when an unprecedented demand for draft animals made them scarce and difficult to obtain.

Probably the best example of the magnitude of the work in the building of a cantonment and the efficiency of motor trucks in transporting materials, is found at Camp Funston, Kan. This is the largest camp in America and has accommodations for 60,000 men. Three thousand freight carloads were received and unloaded at 11 big warehouses in 60 days, an average of 50 cars a day. Five hundred workmen were engaged in removing the materials from the cars and transferring them to U. S. Truck Companies Nos. 46 and 59. The heroic work on the part of the factories in turning out the materials and the railroads in rushing the freight cars to the sidings in the camp was more than matched by the efficiency of the army trucks in delivering the materials to the different buildings in the 31½ square miles of military reservation. Over four thousand buildings were under construction at the same time and materials had to be hauled in sufficient quantities to keep 10,000 carpenters and workmen busy.

Everything from the boxes of toothpicks for the mess tables to concrete mixers, electrical machinery, water mains, boilers, bakery and laundry equipment, was hauled by the trucks in record time. Forty-two additional trucks of three- and five-tons capacity were rushed from the factory in Cleveland to transport the heavy loads. The hauling of 27,000,000 feet of lumber in three-months time was one of the notable achievements. Almost every day several of the machines made trips to Manhattan, Junction City, Topeka and other points twenty to sixty miles distant, for the purpose of bringing to the camp some much needed materials or to unload stalled freight cars in order that there might be no delay in the progress of the work. Frequently these trips were made at night. Over $3,000,000 in currency in wages for the workmen was hauled by the trucks, under a heavy guard, from the banks in Junction City to the camp.

When the troops began pouring in, the work of the trucks was diverted from the hauling of construction materials to transporting foodstuffs, clothing, equipment and supplies for the regimental depots and camp exchanges. Very large quantities of foodstuffs and supplies were hauled by a fleet of over one hundred army trucks at Camp Funston, Kan.

A visitor at any one of the 16 national army cantonments cannot help but be greatly impressed with the system of new military highways which are being constructed under the direct supervision of government engineers from the office of Public Works in Washington. While the highways in each of the camps vary as to length, width, type and general specifications, still they are all intended to meet the demands of military transportation in a camp where all branches of the service are to be trained. Probably the longest and most extensive system of these new highways is found at Camp Funston, Kansas, and extending through the entire 31½ square miles in the Fort Riley military reservation. Plans for this new system of roads provide for 8½ miles of bituminous macadam trunk highways and 14 miles of secondary system which is to be built of water-bound macadam and treated with hot oil.

Good-roads truck hauling stone from the crusher to the cantonment roads

According to the highway engineer who is supervising the building of the Fort Riley highways, observations and tests of military roads along the Mexican border showed conclusively that a bituminous surface of two inches compacted thickness is the cheapest and most serviceable that could be built to satisfy the diversity of traffic in a military city where over sixty thousand men are to be trained at one time. The experiments on the border proved that the damage to the roads under constant and severe military traffic is due primarily to the combination of different kinds of traffic rather than to the gigantic fleets of motor trucks, horse-drawn vehicles, heavy pieces of field artillery or any other single unit. While it is

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Repair Truck for Telephone Work

THE public service companies in large cities always pride themselves on the character of service they give and no one utility is of greater industrial value than the telephone. When ordinary methods of transportation and communication are tied up, one always expects to find the telephone working. The efforts of the wire chiefs and line men to keep the lines in operation are expedited by providing sufficient equipment. The modern motor truck is an important item of such equipment and special types have been evolved that are well adapted for use in emergencies. Saving time in reconstruction work is an important matter and the truck not only has the ability to transport the workmen, but when provided with a properly designed body it can carry all the supplies needed to carry on repairs properly and promptly. In the truck illustrated, provision is made to carry construction materials and tools in an orderly manner. Bins and drawers located at the sides of the body facilitate finding small parts and tools. In the body itself, rope, chainfalls, cables and wire reels, ladders, crowbars, shovels, etc., are stowed away where they can be easily reached. Even the roof of the covered body is made use of, this having racks for carrying the pike poles used in erecting telephone posts. In an emergency that requires quick action, and these occur very often in telephone and telegraph work, the well trained crew lose no time, because they know where all the tools and supplies are and repairs are completed while an ordinary construction gang with the old system of handling supplies would still be looking for the proper tools to complete the job.

A well worked out public service repair truck

Built for the Service Trucks Now Must Yield

PRESENT conditions serve to verify the fundamental truths of motor truck design which Winther pronounced months before the declaration of war of April last.

The lessons of Mexico are now, more than ever, of vital concern to every user of a commercial motor driven vehicle.

The day of the long haul is here.

The time has come, and will obtain for years to come, when the American manufacturer must meet his transportation requirements with the only resource at his command—the Motor Truck.

These are obvious truths. They are acknowledged by everyone.

New conditions have brought new problems, which cannot be solved in old ways. Trucks built for service under old conditions—trucks designed before the long haul was ever thought of, can not reasonably be expected to meet the needs of today.

Ask yourself before you buy any truck what work it was actually designed to do.

Winther Internal Gear Driven Motor Trucks are the direct result of the lessons learned in the one supreme test given American trucks—the lesson of the American military expedition into Mexico.

In every detail they apply to commercial use the facts there learned.

As a result, this new truck, produced in a new plant, unhampered by old policies or investments to protect, built by men rich in experience and with ample capital, has established new standards of motor truck performance—new standards of low costs of upkeep and maintenance—new standards of day in and day out use—a truck built to meet 100 per cent the needs of today—your needs.

Everywhere in this country and in every industry, Winther Motor Trucks have taken their place as the foremost quality trucks produced in America.

No fundamental change has been found necessary in their building since the first Winther took the road—they are built by men who "know how."

There is a Winther Truck for every high grade truck need. From one ton to seven tons, no matter what your requirements now or in the future, there is a Winther of the size and capacity you desire.

Go to the Winther distributer nearest to you—we will tell you who he is, if you do not know him—let him tell you the story of Winther, show you the truck and place at your service, without obligation, the Winther Traffic Engineer, who will glady cooperate with you in a discussion and solution of your traffic needs.

Let us, also, send you the "Story of Winther," full detailed specifications, etc.

To Motor Truck and Passenger Car Distributers and Dealers:

This advertisement is but one unit of our campaign of publicity, placing before the truck-buying public the "Story of Winther." Fundamentally right—marking, we believe, a distinct advance in motor truck design, and proven in service—it offers a remarkable opportunity for dealers who can measure up to Winther standards. In those places where we are not represented, we shall be glad to consider with you the possibility of your finding this a desirable connection.

Model 28, maximum cap. 1 ton
Model 48, maximum cap. 2 tons
Model 68, maximum cap. 3 tons
Model 88, maximum cap. 4 tons
Model 108, maximum cap. 5 tons
Model 128, maximum cap. 6 tons
Model 148, maximum capacity 7 tons

WINTHER MOTOR TRUCKS
WINTHROP HARBOR, ILL.

Winther Motor Truck Co.

Dept. H, Winthrop Harbor, Ill.

The Current Supplement

ONE direction in which the war will undoubtedly result in great benefit to humanity is the advance that it will make possible in medical science, for the vast accumulation of authentic records will constitute a fund of information for study and comparison such as has never before been available, and from which wonderful results may be anticipated; and this appears to be particularly the case in the investigation of psychological problems. An early study in this direction will be found in the paper on *War Psycho-Neurosis* which will be found in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2202 for March 16th. *Fighting Snow Drifts on the Railways* tells of some of the methods adopted for mitigating the effects of a serious obstruction to our winter transportation, and is accompanied by novel photographs. *The Crust of the Earth* gives general facts about the composition of the surface of our globe, and is accompanied by a number of drawings illustrating the various dislocations and contortions that are exhibited in geological formations that will make clear many scientific terms that are frequently met with. Another of the popular papers on *Anomalies in the Animal World* appears in this issue, which deals with flightless birds, and is accompanied by a large number of excellent illustrations. *Longitudinal Sleepers for Railways and Tramways* describes and illustrates a new method of railway construction employing concrete. *Comparing and Setting Clocks* describes a short method of making and reducing chronograph comparisons of clocks running on Standard time and Sidereal time which has been developed by members of the staff of the U. S. Naval Observatory. Other articles include *Beyond the Microscope*, which deals with masses too minute for observation by the ordinary microscope. *Nutrition of Oysters* and *Castings from Ingotted and Other Scrap Metals.*

Masterpieces of Primitive Engineering

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from the top down. No less remarkable than the sementeras are arrangements for water supply. Philippine mountains are full of small streams that seldom or never cease to flow. These streams are diverted from their natural courses, in some cases being wound for miles around the sides of the mountains, passing over deep gullies and even rivers in wooden troughs or tubes—for the making of which the natives of course have only what a good union man would consider the most hopelessly inadequate tools.

Every drop of water is precious, and no drop is allowed to go to waste. The sementeras themselves are built by the individual labor of the holders, the irrigating systems by the combined efforts of all land owners who will benefit. It is not permissible for a man to hire his share done, or discharge his obligation in any other way than by performing it himself. If he refuses to do this his neighbors will go ahead without him, and he may draw no water from the source of supply thus built. The arrangements for proper apportionment of water are simple; instead of allowing each holder to use a certain amount all the time, the easier expedient is adopted of giving each man all the water for a certain time each day or week. The natives not only find this more administrable and fairer, but they believe that the fields do better with plenty of water part of the time than with a little water all the time.

The usage in regard to maintenance of water rights is interesting. If a man is on guard at his water gate, his rights are recognized and protected against all invasion; if he dozes off under the long strain and a less sleepy neighbor shuts his gate and steals his water, the thief will be badly beaten by the community as a whole, and redress will be given from the culprit's own water supply. But if a man does his sleeping in his hut in the village, leaving his water gate on the distant hillside unguarded, he is considered to have waived all claim to communal protection of his rights by failing to do his own part in their defense; and his water may then be stolen with impunity, and, of course, will be.

An interesting feature of the irrigation practiced by the Igorots is that it is combined with fertilization. The water on its way to the sementeras is run through masses of manure, ash, black alluvial soil and decayed vegetable matter, and of course carries the soluble portions to the rice fields with it.

In the building of the irrigation system proper—the direct means for diverting the mountain waters into the sementeras—communal labor, as we have indicated, is employed. Everybody concerned lends a hand, and ostracism follows refusal to do one's share. The construction of the terrace, on the other hand, is wholly an individual affair; and a man may accordingly expand his agricultural holdings to the fullest extent of his ability to work them.

As our pictures show, the sementeras soon come to cover the whole mountain and afford a striking scenic effect. In the words of A. E. Jenks, who describes them in a publication of the Ethnological Survey, "Winding in and out, following every projection, dipping into every pocket of the mountain, the walls ramble along like running things alive. Like giant stairways the terraces lead up and down the mountain sides; and whether the levels are empty dirt-colored areas, fresh green-carpeted stairs, or patches of ripening yellow grain, the beholder is struck with the beauty of the artificial landscape and marvels at the industry of an otherwise savage people."

Alcohol—A Large Chemical Family

(Continued from page 230)

noteworthy effort has been that utilizing wood waste such as sawdust. Two plants are now operating on this plan, the combined daily output being approximately five thousand gallons. The method is attended by many technical difficulties and may be said to be just emerging from a period of commercial development. In practice the wood waste is treated with sulfuric acid in a manner to convert a portion of the cellulose into soluble fermentable sugars. These are dissolved out, yeast added and the resulting alcohol obtained by distillation.

Attempts thus to utilize waste products and so conserve materials of food value are very commendable and may eventually, in addition to other benefits, make available large quantities of cheap alcohol for use in the industries which have been retarded due to the high price of this important solvent.

Denatured alcohol was introduced for this purpose. In all countries the manufacture of alcohol has been made a means for raising revenue and in normal times the tax is about five times the cost of manufacture. This tax constitutes a heavy burden for several industries and to encourage these without decreasing the income from other users, denatured alcohol has been legalized.

Denatured or industrial alcohol may be defined as grain alcohol which has been rendered unfit for use as a beverage or as a liquid medicine by the admixture of some suitable soluble material which can not be easily separated from the mixture. The usual denaturants are methyl or wood alcohol, benzine and pyridin which is an evil smelling substance obtained by the distillation of bones. Ordinary denatured alcohol is thus rendered poisonous and should not be used internally or externally. Denatured alcohol has an endless variety of industrial uses and special denaturants selected with reference to the use to which the mixture is to be put may be chosen and the special formula authorized by the Government representatives. Among the special denaturants may be mentioned shellac, copal resin, colophonium, manila gum, camphor, turpentine, acetic acid, acetic ether, ethylic ether, methyl acetate, naphthalene, castor oil, carbolic acid, caustic soda, nicotine, petroleum, naphtha, benzol, acetic anhydride, sulfuric acid, vinegar, crude chloroform, kerosene, anhydrous zinc chloride, animal oils, musk, fluorescein and a variety of dyes such as

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Alcohol—A Large Chemical Family

(Concluded from page 238)

malachite green, eosin, methyl violet, anilin blue, etc.

Some denaturants can not be used if they in turn are impure as for example, the acetone usually present in methyl alcohol would make denatured alcohol containing it unsuitable for the manufacture of certain dyes.

Alcohol is used in a great variety of ways. Fifty dyestuffs require the ethyl or methyl variety and there are more colors outside the textile industry depending upon alcohol. It is used as a source of heat, as a source of light in alcohol lamps, and when mixed with some fifteen to thirty per cent benzol is an excellent fuel for motors. It enters into the manufacture of artificial silk, inks, celluloid, lanolin, collodion, smokeless powder, fulminates, anaesthetics, drugs, synthetic perfumes, artificial fruit flavors, photography, sulfuric and nitrous ether, acetates, vinegar, production of plastics like phonograph records, certain soaps, shellac solutions, varnishes, lacquers, and many more.

When denatured alcohol was legalized in 1906 many thought that this would lead to the establishment of small plants operated by farmers as is the case in Germany where there are more than seventy thousand farm distilleries. Most of these are very small and some produce no more than fifteen gallons annually. These are crude affairs attended by the farmers in the winter months when there is little else to do, but our Government regulations are not such as to encourage a similar industry in America. These small German stills are provided with a receptacle which after inspection is sealed by the collector of Revenue to be reopened and the contents gaged by him at some later date after notification that the farmer has ceased operations for the year. The alcohol so produced is purchased by the large central organizations who obtain a rebate from the Government for the tax paid by the farmer should the alcohol be denatured for industrial purposes.

Methyl alcohol is quite poisonous and even the fumes have many ill effects. This has caused an investigation to be made concerning the occupational diseases arising from its careless use.

Before the war two million wine gallons of denatured alcohol were used annually in the United States; the present consumption exceeds ten million gallons. In 1914, 174,611,000 gallons of distilled spirits were produced in the United States, and in 1917, 277,834,000 gallons. How misguided have been those who constantly endeavor to drink it all!

Concerning Fuel

(Concluded from page 234)

value for his money; but the report adds, "It is evident that slightly more could be delivered to the customer for a dollar with the lower heating value gas." "When gas of high candle power is sold, the supply is irregular owing to the difficulties of transmission." "The public would seldom lose and might gain a great deal if heating value and price were reduced." "The present system of gas rating gives results which are not suitable for the customer or for the service." "High candle power gas blackens utensils. Low candle power gas will usually give more heat than high candle power gas." "Gas which costs six times as much as hard coal may be cheaper than coal," because 90 per cent of coal heat is often wasted through the oven or up the chimney. "The liberal use of newer lamps might reduce the yearly consumption of coal in the United States $8,000,000."

The question at once occurs—why not abolish candle power standards and still retain heat standards?

Two important reasons.

The "old line" companies are the only ones to whom the sale of gas as an illuminant is important. They have grown prosperous on the old order of things. They inquire why disturb present standards? They are sure of satisfactory dividends with gas at 80 cents to a dollar. They are loath to bestir themselves to the necessary mental and physical effort while users of gas pay at a dollar and at 80 cents, even though thereby they might secure 5,000,000 users of gas at some lower price.

Second, suppose you do abolish candle standards for a heating gas and retain heat standards of 570 to 600, as New York State has done, while you have taken a decided step in the right direction you still are a long way from making it possible for the gas companies to give you the most for your dollar. For example, the gas made by distilling sawdust, stumpage and other wood waste comes far from the New York standards but by burning 2,000 feet instead of 1,000 it performs just as useful work as the gas of higher heat content, and the cost per 1,000 heat units is less.

The scientists says, "Let us get together and make standards that are fair to all and which at the same time will let us use nature's products and the by-products with the greatest good to the greatest number. Above all, let us change standards as the need arises, instead of as at present chafing under restrictions based on standards that should have been relegated to the scrap heap long ago, and we will transmit heat and power through pipes and over wires and eliminate waste on such a scale as the world has never yet dreamed of. Let us go further," says the scientist, "and let us reduce the cost of living by eliminating waste in the transportation of these things, commodities, which cannot be transmitted through pipes and over wires."

As to that other bugaboo of the conservationists, exhaustion of gas pools and oil wells and coal beds, in view of the enormous demands for oil as motor fuel and coal as the foundation industry of gas, spite of the fleets in the air and the fleets on the sea and the fleets under the sea the biggest scientists have no fears. As John D. Rockefeller used to say to Dr. McDowell, his young scientist in the early oil days, "God Almighty does not run a retail business. He runs a wholesale business; and the deeper you go in the depths of the earth, the richer and fuller you will find supplies in His laboratory."

Imagine New York this winter if all fuel had been piped to it, to be turned on by a tap! There would not have been 700 miles of cars tied up with coal; for the big utility power houses would have laid in supplies years ahead. There would not have been coal tugs tied up by ice in the harbor. There would not have been teams falling all over icy streets trying to put coal in cellars. There would not have been burst water pipes in pretty nearly every apartment house in the city. You would have turned on the fuel in the gas main; and there you would have been.

As to costs, manufactured gas can never be as cheap as natural gas; but change the standards, taking out such expensive ingredients as benzol, and Doherty's theory is the cheaper you can make gas fuels, the more the public will use them. As for the cost gas *vs.* coal, a test was tried out in Denver with the bakers. It cost 15 cents in coal to bake 100 loaves of bread. It cost 8 cents in gas.

Certainly the fuel crisis has wakened us all up to the folly of burning silks for fire wood and diamonds for coal.

What Machinery Means

(Continued from page 234)

roughest kind of work, like sewing burlap bags, the sewing machine gives a factor of seven; 3,500 bags per day against 500 by hand. For finer commercial and domestic sewing this figure is considerably reduced. Salt bags are filled and stitched by two girls at one machine at the rate of twelve thousand per day, perhaps ten times as fast as by hand.

In the cordage industry we have a closer approach to the performance of the printing press, again because hand work is very slow. Of a stated quality of cord, the showing is 880 pounds per day against 50; of a peculiar curled hair fabric, a by-product, 1,200 pounds by two workmen against 25. Of these factors of 17½ and 48, the former appears more nearly representative of the industry. On the whole, taking into account that many of the hand processes replaced by this type of machine

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What Machinery Means

(Continued from page 240)

were slow ones—the very fact that a machine to do them demands an operator's whole attention testifies to this—a figure of 10 does not seem excessive as a general estimate for the single unit machine in all fields.

The Web Press and Its Little Brothers

There are many machines that so revolutionize the way of doing things that there can be no comparison with the hand worker sufficiently close to justify either of the preceding classifications. One such type is that which receives the raw material in bulk, and delivers the finished article—more often than not, counted and packed. It will be clear that the web press for newspaper printing falls in this class. The largest of these yet made turns huge cylinders of paper into finished news sheets at the incredible rate of 288,000 eight-page papers per hour. To do this 10 operatives are employed, so we have 230,400 printed pages per man per hour. This is something like eight thousand times as fast as Ben Franklin could have done the job.

For the reason already emphasized that few hand operations are as slow as printing, this figure is excessive in its class. In the manufacture of the common brass pin three men now produce 7,000,000 pins per day against 48,000 pins by 10 men under an old process, the factor being 500. Somewhat smaller is the economy in the continuous process machines which make small envelopes and cardboard boxes at the rate of two hundred and fifty thousand or three hundred thousand per day, from two hundred and fifty to four hundred times as fast as the work could be done by strictly hand processes of cutting, folding and pasting.

An immense variety of small and large wooden and metal parts for direct sale or for further assembling in the factory making them is turned out on machines of this type. I have before me a small brass binding post, thoroughly representative of this sort of thing. The automatic machine designed for the purpose turns out 5,000 of these per day; a hundred years ago, by foot lathe and hand work entirely, 20 per day would have been an excellent showing. This factor of 250, typical here, is reduced when we consider the making of wooden articles, since hand work on wood is comparatively easy. Thus we have the turning and fitting of gun stocks, one of which was formerly an all day job for one man, while today three men complete 150 in the same time, giving a factor of 50.

The Factory System

The general average of at most 300 indicated by these figures for the continuous process method is valid only when a single machine finishes the work which it begins, when there is no assembling of the product of many machines. But when this state of affairs is out of the question, the modern factory itself is often organized on the continuous process plan. Raw materials flow in in a steady stream, passing from one machine to another, until they are finally brought together and emerge at the shipping platform as the finished product. Automobiles and shoes and canned goods are among the commodities whose mode of production is best known to follow this plan. The operations performed at a single machine seldom have a counterpart in hand work, where one man, all by himself, builds a whole pair of shoes or a carriage or puts up a crock of salt meat. Hence the only thing we can do in the way of comparison is to divide the total output of the factory by the number of employees, and compare the output per man thus found with that by a single hand worker.

We need not expect that when we have done this our figures will be at all of the same order as those for a single continuous process machine. In the first place, it is only an article of simple and homogeneous structure, like a newspaper or a pin, that can be produced entirely by the very high speed operations. When we make anything so complicated and heterogeneous as a pair of shoes or an internal combustion engine, we will inevitably find many

operations that must be done by the slowest of machines, or even by hand; and these govern, for we must either slow down the faster items to the pace of these slower ones, or employ a disproportionate number of men at the slow jobs.

Again, when John Shoemaker sits him down on his own front step to make a pair of shoes for the butcher, there is no non-productive labor; every second of the worker's time spent in work goes to the advancement of the job in hand. In the big factory this is not the case; there are, perhaps, hundreds of workers who never handle any part of the finished product. And finally, the shoemaker buys many small parts, such as eyelets and laces, as well as certain intermediate articles like specially tanned leather and specially prepared thread, which in the big factory are worked up from the raw.

All these items either constitute an integral part of the factory system, effecting a legitimate reduction in its apparent working efficiency, or else are the causes of unavoidable error in comparing that system with hand work. To this must be added the fact that few factories are organized to the ultimate point. A machine installed in a big automobile factory the other day makes it possible for two men to ream 150 sets of crank-shaft bearings per day, where heretofore a single set has been a good day's work for one man. I don't know how many years this factory has been reaming these bearings in the old way, and nobody knows how many other things they are still doing as badly as they did that; but true figures under both heads would doubtless be sufficiently appalling.

From all this it appears that the general average for factory production of assembled articles will be low, and that the figure arrived at will represent merely the present state, rather than the ultimate possibilities inherent in the system. With this understanding, I will state that a given number of men working in a factory will turn out five times as many shoes, four times as many brooms, five or six times as many carriages (*not* automobiles), four times as many agricultural implements, as they would if working by hand, under the old scheme. A fair general average for factory assembled goods would be about five.

Where Work Is Put Up in Big Packages

There is one more class of machinery to be recognized, that employed in certain bulk operations, and effecting its economy by taking a bigger bite of the work than a man could handle. A bucket dredge of reasonably good size multiplies the efficiency of the worker by about one hundred. The lifting and loading magnet moves 90 tons of metal per man per hour, against 1½ tons by longshoremen in the old way—a comparative value of 60. When it is possible to keep a conveyor belt of considerable length moving and working continually, it is not unusual for it to do the work of from twenty to fifty men. Very large loading and unloading equipment like that used in handling the Great Lakes ore shipments may replace almost any number of men from 100 up; the bigger the job, the bigger the saving.

Power transportation is another field where machinery of this bulk-handling type holds sway. The motor truck is a bit disappointing, its forte being rather the replacing of a few men and its ability to work under all circumstances. Conditions vary so widely that a general statement is difficult; some motor truck fleets have only cut in half the number of men necessary, others have enabled one man to do the work of from twelve to eighteen teamsters. I should think that 5 would be a fair general average, for all conditions and all types of work.

The unit of railroad transportation is the ton-mile of freight. For the last full year before the war (1913) our American railroads accounted for 300,000,000,000 of these units, and, on and off the trains, they employed 1,800,000 men. As far as I can determine, 140,000 of these men are to be identified with the passenger service, leaving 1,660,000 for the business of handling freight. On this basis we find that the railroads render 180,000 ton-miles of freight service per year for each employee engaged in that work.

In hauling freight by horse truck, 25 miles per day with a two-ton load would be an excellent showing for a single vehicle under all conditions. If we assume, conservatively, that this vehicle represents two workers—one on the truck and one in the stations—and that these men work 350 days per year, the annual individual output of transportation would be 9,000 ton-miles. So the railroad multiplies by 20 the efficiency of the man engaged in distance hauling of freight, and this in spite of the necessity for having 4½ workers off the trains for every train hand. Moreover, in the ideal state of affairs to which we are now apparently verging, where the shipper and the consignee and the 48 State Legislatures shall be deprived of their accustomed privileges of routing and otherwise dictating how the railroads shall perform their functions, it is not unreasonable to hope that the efficiency of our freight carriers will be doubled. But since the railroads represent such a very large proportion of all the bulk work done, and since we are looking at things as they are, it seems hardly possible to name a figure greater than 25 at the outside as the general factor for all bulk operations.

I hesitate to draw a general conclusion, to state that today, taking all fields of activity as a whole, one man does the work which it would take x men to do by hand. What is the value of x? To answer this question would require a greater insight than I possess into the distribution of the several types of machinery. It would in particular require a very keen insight into the extent to which the figure given for factory assembling properly swallows those given for the specific machine types. Plainly it swallows these figures to some extent, since in the factories to which it applies are found many machines of the other types. But how large this condition should bulk in making an estimate I do not know. My best judgment is that one man today is, productively, worth 10 men of the period 1750-1800; but I would not willingly be called upon to support this impression with arguments.

It should be emphasized again and again that I have considered absolutely nothing except direct saving in labor. Almost everything is better done than it was by hand, in spite of exceptions and in spite of pessimists. Many things are done which could not even be done at all without machinery. Vast collateral savings in floor space and in cheap non-productive labor have been effected by compact machinery. In the present discussion, all these advantages of machinery have had to be ignored entirely—for they are not pertinent to the question with which the discussion started.

Expediting Construction Work at Army Cantonments with Motor Trucks

(*Concluded from page 236*)

true that the cavalry and gun carriage horses are shod without calks, nevertheless, the horses roughened the surface and the heavy guns very rapidly completed the destruction. A bituminous surface prevents to a great extent the roughening of the roads and is but little damaged by the transportation of the heavy guns.

Approximately six miles of the new main trunk highways through the reservation connects the Golden Belt—Kansas City to Denver—highway on the eastern boundary of Camp Funston and extends to the Fort Riley army post. From the fort there are two highways, each 2.6 miles in length leading in the direction of Junction City, where they will join with new brick roads which are soon to be built by the municipality. The first section of the road through the Funston cantonment to Fort Riley is intended to accommodate both military traffic and the traveling public and for that reason is to be 30 feet in width, while the two highways leading from the fort to Junction City are but 16 feet in width. The cantonment trunk road system consists of five east and west roads and four north and south roads which are considered as trunk roads only. The secondary highways through the regi-

mental units are to be known as regimental streets. They are to be but 16 feet in width.

A specially designed "Good Roads" truck purchased by the government shortly after the road building program was started has been an important factor in speeding up the work. It has been used to haul, dump and spread thousands of yards of rock used in the construction of the roads. While teams of horses and mules were also used it is estimated that the truck did the work of at least 12 teams. The truck hauls forty to fifty tons a day over an average distance of six miles per round trip. A truck distributor of hot bituminous material proved another valuable asset to the work. This truck was used to spread thousands of gallons of hot asphaltic oil to the road surface under a penetrating pressure. Later when the regimental streets are ready for treatment it will be assigned to spreading oil over these highways.

It is stated that 200,000 cubic yards of rock were needed to build the 21 miles of highways, the necessary culverts and bridges. The rock is obtained from Packer's hill located north of the main Golden Belt Highway and midway between Camp Funston and Fort Riley. The rock after being crushed to the proper size is hauled in the trucks and wagons to various points along the road. The quarry from where the rock is obtained contains an unlimited quantity of dolomite running uniformly nine feet thick in the ledge, 2½ feet of which is flint. Two rock crushers erected on the side of the hill have a capacity of 700 cubic yards of rock per 10-hour day and all rock is screened to four sizes. Both crushers are electrically operated. They crush the dolomite and flint as it comes. The rock is drilled with jack hammers and the overburden is about two feet in average thickness. The quarry force consists of 60 men, ten dump carts and two wagons.

The quarrying of stone and the transportation of the material to the road side is being handled directly by the United States road division. The Government hires the workmen, buys the necessary materials and delivers the crushed rock to the contractor on the road. The actual building of the road is handled by private contractors, but is subject to government supervision. According to the engineer in charge it costs the government 95 cents a cubic yard to crush the rock and 40 cents additional to deliver it to the job, six miles away. This cost may be considered high, but it is due to the high scale of wages made necessary by the shortage of labor and war conditions. In addition to the building of the new highways, the engineering staff have looked into the future and have provided for an organization which will keep the roads in good condition after they have been constructed. For this work a maintenance force has been organized to take over the roads as fast as they are completed and to repair the damage as fast as it appears necessary to do so.

Bicuiba Oil

As the raw commercial products of tropical America are now attracting increased attention among American manufacturers, it may be of some interest to refer here briefly to one of the little-known, though valuable vegetable oils, which through thrift and industry may be turned to practical account for various uses. The demand for oils is very great and the market can not be supplied with sufficient quantities to keep our large manufacturers in full operation. Tropical America is looked to as the region from where these much-needed supplies are at least in part to be drawn. There are numerous valuable oil-producing seeds and fruits growing in great abundance in the American tropics, which are hardly ever prepared with sufficient care to make them profitable articles for export. A brief description of one of these products may prove of interest to the general reader.

The Brazilian bicuiba tree, as it is commonly called, is the plant that produces the seeds from which the bicuiba oil is obtained. It belongs to the nutmeg family of plants and is the *Myristica bicuhyba* of the Brazilian flora. It is one of the 260 or more important tropical, fragrant and aromatic trees of which the true oriental nutmeg is the best-known example. The bicuiba tree which is found principally in the provinces of Minas Geraes and Esprito Santo, is from thirty to fifty feet in height and from two to three feet in diameter. It produces an abundance of fruits which are succulent two-valved capsules containing each a single seed. The seeds or so-called "oil nuts" are variously known locally as urucaba, ucuhyba ucuhuba, becuhyba or bicuhyba nuts. The kernels are about the size, form and structure as the true nutmeg of the shops, and have an agreeable cocoa-like odor and a taste resembling that of cocoa butter though somewhat bitter and suet-like.

The oil is principally in the kernel. By macerating and subjecting these to hydraulic pressure approximately 50 per cent of a solid or fixed fat (vegetable fat or tallow) is obtained. As high as 60 per cent of fat has been obtained by efficient methods of grinding and expressing. It is of a yellowish brown color and upon cooling the surface becomes covered with a white crystalline efflorescence. When melted it becomes dark brown and congeals with a wavy surface. It is said to melt at about 109 degrees F., and congeals at about 90 degrees F.

It is to be regretted that no serious attempt has yet been made for collecting these seeds systematically and for expressing the oil for the many important economical uses to which this vegetable oil is subservient in the manufacture of soaps, candles, etc. It burns well in the form of candles and the finer grades give a pleasant and good light. Bicuiba oil is also used locally for medicinal purposes in the treatment of rheumatism and dypsepsia, but it is not recognized by the U. S. Pharmacopoeia.

It has been estimated that the average bicuiba tree in Brazil produces about thirty-five pounds of fruits or about twenty-one pounds of kernels which yield 10 pounds of a good grade of oil or fat valued at about fifteen cents a pound at source of origin. The high initial cost of the oil to which must be added the cost of freight from a Brazilian port to New York, makes the price of the product almost prohibitive. It is believed, however, that a little later the oil can be prepared for much less and that it will come into general use for technical purposes.

Better Canning Rubbers

THE experts of the Department of Agriculture have been investigating the part which inferior rubber rings played last year in the spoilage of canned products. It appears that housewives would carefully can fruit and vegetables according to the approved methods, and yet this spoilage would occur. This was because of the worthlessness of many of the rubber rings used. They came with the jar and were intended for the old style of canning by the open kettle method, where the glass jar and the rubber ring did not come in contact with the sterilizer. This method was used almost exclusively for fruits, because there was until recently no well-known method that would successfully can vegetables and meats in the home. The method instituted by the government is a thoroughly satisfactory one; but it required that the rubber ring go into the boiling liquid, and the rings in use were of such poor quality that they were ruined in the process. Thirty-five per cent of the total spoilage of last year was chargeable to this cause.

To meet the requirements the ring should fit closely, requiring a little stretching to get it around the neck of the jar. For standard jars the ring should have an inside diameter of 2¼ inches; and a width, or flange, varying from ¼ to 11/32 of an inch. The tests made showed that fewer cases of "blow-out" occurred when the flange was 11/32 of an inch. Rubber rings found on the market may vary from 1/16 to 1/32 of an inch in thickness. Tests showed that 1/32 of an inch in thickness is sufficient to take up the unevenness in the jar and still not so thick as to make it difficult to place the cap or

adjust the bail. Cold-pack canning requires a rubber ring that is tough, does not enlarge perceptibly when heated in water or steam, and is not forced out of position between the top and the jar by slight pressure within the jar.

The experience gained by the department investigators has been formulated in a set of standard specifications for rubber jar rings. These specifications have been voluntarily adopted by the manufacturers, so the loss from this cause should be got largely under control during the coming season.

Importing Insect-Destroying Animals

EXPERIMENTS are being made by Texas vegetable planters with an animal called the ant bear, whose native home is in the central portion of South America, as a means of destroying potato bugs and other insect which prey upon growing plants, especially those of tuberous growth.

Prof. Luiz Herrera, formerly of the government experiment station of the City of Mexico, has secured several of the animals and they are now being acclimated in southern Texas. Professor Herrera is an authority on vegetable-destroying insects and while exiled from Mexico for several years because of his political beliefs, resided in Brazil and Columbia. While there he studied the ant bear, or ant eater, and finally shipped four, three females and one male, to a vegetable grower of his acquaintance living near Morgan City, La. The animals were put in the vegetable gardens of the neighborhood with considerable success during the summer of 1916. At the beginning of the winter season, however, the animals died, the cold weather of the northern country being fatal to them.

Professor Herrera, who has returned to the City of Mexico, has secured 24 of the animals, eight of which have been shipped to southern Texas. The others will be kept on a plantation near Vera Cruz, the climate of which is identical with that of the portion of Brazil where the bear thrives.

The ant bear destroys what is commonly known as the potato bug, locusts and other injurious insects, with little injury to the vegetation on which such pests are found.

Professor Herrera, who claims credit for having called the attention of the southern planters to the Guatemalan ant, which has been imported in large quantities by the United States government as a prevention of the cotton boll weevil, estimates that the ant bear will effect a similar saving to southern vegetable growers.

Unlike its northern cousin, the ant bear does not hibernate during the cold season, the original habitat of the species having been in warm climates. The importer has designed a "domesticating pen" which is similar in construction to a vegetable hot bed, and kept heated in the winter. He estimates that the third or fourth breeding in the United States will have become acclimated so that artificial heat during the cold season will be unnecessary.

Coal Fatalities in the United States During 1917

THE abnormal conditions under which coal mines were operated during 1917 are reflected in the accident records to the extent of an increase of 21 per cent in fatalities over 1916, according to Albert H. Fay of the United States Bureau of Mines. The reports of the coal-mine inspectors to the Bureau of Mines of the Department of the Interior during 1907 account for 2,696 fatalities at the coal mines of the United States, as compared with 2,226 for 1916. There has been and is still an unusual demand on the operators for an increase in coal production which has been hampered by a congestion in freight traffic, and an apparent shortage of labor. Available data indicates an increase of less than ten per cent in production. It is not possible to give the number of men employed in 1917, but the preliminary reports to the U. S. Geological Survey indicate that in some states there was a slight increase in the number of men employed, while in others there was a small decrease. Estimates by State mine inspectors in 15 of the smaller mining states, representing one-fourth of the industry indicate about ten per cent increase in the number of employees. Therefore, the total number employed in 1917 may not be much in excess of 1916, viz., 720,971.

Those mines which were able to secure cars to market their coal were operated on a full-time basis, which adds to the number of days the individual miner could work, thus lengthening the time he was exposed to the mining hazard. The risk encountered by the individual miner is proportional to the time exposed. Other mines which were not so favorably situated as to dispose of their coal operated only part time. This condition results in an increase of certain dangers, especially those due to gas, dust and falls of roof, which would not obtain in the case of the mine operating full time. The active mine will ordinarily be kept in better condition than one operated only part time.

The shortage of mine labor, required to keep pace with the increased demand for coal, is due to the attractive wages in munition factories, enlistments and drafts into the army, a relaxation in immigration, and to emigration of many miners early in the war. It has been necessary, therefore, to employ new and inexperienced men from other fields to replenish this shortage. Many of the experienced mine foremen and safety engineers have either enlisted, or been drafted into the army, or secured more remunerative employment elsewhere, with the result that less experienced foremen have been placed in charge of some of the workings. With the exceedingly large demand for coal, it has not been possible for the operators and others concerned to give as much time and attention to accident prevention at the mines as was being done in recent years under normal conditions.

Paints Which Are Sensitive to Temperature Changes

TEMPERATURE sensitive paints is the term applied to chemical compounds that are subject to color changes at a comparatively small rise in temperature. These paints are occasionally used for indicating a dangerous rise in the temperature of machine bearings, electric generators and other apparatus where excessive heating has to be avoided.

The two compounds described by W. S. Andrews in a recent issue of the *General Electric Review*, are given below. They are easy to make and reliable in operation.

Double Iodide of Mercury and Copper.—This compound is normally red but turns black at about 87 degrees C., becoming red again when the temperature falls. To prepare it, make separate solutions of copper sulfate and potassium iodide in distilled water. Add the latter to the former with constant stirring until the precipitate which is first formed is redissolved. Then add a strong solution of mercuric chloride (corrosive sublimate) and the red double iodide of mercury and copper will be precipitated. Wash and dry this precipitate on filter paper. The red powder may be mixed with a weak solution of gum arabic in water and used as a paint.

Double Iodide of Mercury and Silver.—This compound is normally of a light primrose yellow, but turns to a dark orange or brick red at about 45 degrees C. It becomes yellow again on cooling—and it may be heated and cooled an unlimited number of times without losingi ts curious property, providing it is not overheated. To prepare it, make separate solutions of silver nitrate and potassium iodide in distilled water. Add the latter to the former with constant stirring until the original precipitate is dissolved. Then add a strong solution of mercuric chloride (corrosive sublimate) which will produce a precipitate of the double iodide of mercury and silver of a bright yellow color. Wash and dry the precipitate on filter paper. It can be used as a paint by mixing with a weak solution of gum arabic in water.

A New Method of Destroying Mosquitoes

AT a recent session of the French Academy of Sciences an interesting method of handling the mosquito plague was set forth in a note by Messrs. Edm. and Et. Sergent, who have conducted an anti-malaria campaign in Algeria for the last 15 years, making use of all the approved anti-larval measures, such as draining, filling, bricking and cementing, mowing down grass and weeds, and treating stagnant water with kerosene.

During the past few years, however, they have experimented with the following method, which though somewhat limited in application, has the great merits of simplicity, easiness, and cheapness, and is therefore highly recommended by these experts for localities where it is suitable. The Sergents were struck by the fact that many villages were infested with mosquitoes, not because of extensive swamps or marshy regions in their vicinity, but from a comparatively small number of local breeding places, such as irrigation ditches, horse-ponds, the drains from wash houses and public wells or fountains, and sluggish streams and slow moving rivers fed by small springs.

Knowing that the larvae of the Anopheles require from two to three weeks of aqueous life in order to develop into the winged insect they conceived the idea of "alternating breeding places." For example, instead of allowing the waters of a spring to flow off through a single channel two channels are dug, and by means of an earthen dam, or a pair of water gates the water is alternately diverted from one channel to the other at intervals of a week. The larvae which have developed in the course of the week are promptly destroyed when the water is cut off from their breeding place, which rapidly dries out under the summer sun. The same idea is carried out in ditches, drains, etc.

"Turn by turn, each ditch is filled with water for a week and then dried out during the following week. The only work required consists of a few strokes of a pick once a week to demolish the earthen dam in one ditch and build it in the other, or else the manipulation of two water gates."

The authors of the plan declare that the results are admirable with a minimum amount of attention and that this technique reduces the expense to not more than one-tenth of the cost of the measures usually adopted in mosquito fighting. It is to be hoped that communities where the given conditions prevail will make trail of it this summer, since the advancing cost of kerosene may be prohibitive of its use so freely as heretofore for killing these pests.

Why you Should Eat Oysters

THE oyster production of the United States is the greatest in the world. It can be made much greater because vast areas of unproductive bottom can be made productive by oyster culture.

The purity of oysters placed on the market is now more assured by United States and State inspection and the coöperation of the large producers. Don't be afraid of green-gilled oysters. The gray-green color, which is of vegetable origin and derived from their food, forms a deep fringe within the open edge of the oyster. Such oysters are often the best and in France are prized by lovers of seafood above all others.

Therefore, eat oysters.

It is a duty to utilize this vast food resource as far as possible and save other foods of which there is a dearth. It is also a pleasure to use the oyster which in other countries than ours is a luxury rather than a common food. It is not one of the cheap foods when measured by the cost of its useful constituents, but it is valuable as an appetizing variant of the diet. A reasonable variety of food is necessary to the health of a civilized people.

The oyster is without waste, digestible, wholesome, and delicious, and it may be prepared in many ways. If you wish to know how, write for a cook-book to the United States Bureau of Fisheries, Division F, Washington, D. C.

Notes and Queries.

Kindly keep your queries on separate sheets of paper when corresponding about such matters as patents, subscriptions, books, etc. This will greatly facilitate answering your questions, as in many cases they have to be referred to experts. The full name and address should be given on every sheet. No attention will be paid to unsigned queries. Full hints to correspondents are printed from time to time and will be mailed on request.

(14269) F. M. F. asks: I have some lantern slides which were so heavily impregnated with alum in fixing that they will not take the pigments in coloring. We use the Dunne's Pastel colors. Is there any way of remedying these plates? They are beautifully clear slides, and I wish to save them if possible. A. The action of the alum upon the geletine film of a lantern slide is to harden the gelatine. In other words the alum *tans* the gelatine just as leather is tanned, making it insoluble in water. It ceases to be able to absorb water. It is for this reason unable to take in the water colors. We do not know any way to change the gelatine back again, so that it can absorb water. There are two ways in which you may prepare the slides so that they will take the water colors. One is to coat them with a layer of gelatine; the other to fix an unexposed plate by dissolving the silver with hypo, ordinary hypo without alum, and do the coloring upon that plate, being careful to match the outlines on the real slide. This can be done by fastening the two glasses together back to back, and after coloring the plates, placed face to face, will match. The color is on one glass, the picture on another. The effect is the same and the manner in which it is done cannot be distinguished on the screen. We have frequently used this method.

(14270) S. C. asks: Is the receiver of the wireless apparatus consuming electric current? If so, when and from where? A. The receiver of a wireless telegraph receives the electric waves from space and they pass through it to the earth. Their impulses act upon the receiving telephone and thus do work. They are no different from other electric effects excepting that they are very minute. Since they flow over a wire they must act upon the wire just as any other current does and so there is a consumption of energy in their passage over the aerial and through the receiver. The energy is derived from the impulses sent out from the transmitter.

(14271) J. F. W. writes: In the query of H. A. S., No. 14235, answered in issue of August 4th, does not the dispute referred to arise from a difference of understanding of the exact premises? In the case of a 4-wheeled vehicle overturning around a curve, of course as you state, the inside wheels leave the ground, centrifugal force throwing the vehicle over outward. *But* if the vehicle is made to make the surve successfully by the passengers throwing their weight to the insides as is regularly done in automobile road racing, then it often happens that the *outer* wheels leaves the ground. The curve in the roadway should properly be banked for high speed passage, but when it is not, the outer wheels of the car might easily *have* to be raised from the ground by the passengers leaning inward, to avoid being thrown over outward. A. If the passengers lean inwards in rounding a curve and thus overcome centrifugal force, it is by the shifting of the center of gravity and holding the inner side of the car down. A sliding of the car might result in which case the outer wheels might leave the ground if any wheels left it. It would not be probable that the car could overturn in these circumstances.

(14272) R. C. S. asks: Can you, without undue inconvenience, give me an explanation of the following: Take an oval-shaped tin can, an ordinary 10-cent "Prince Albert" tobacco can for example, and fill it full of water, now by squeezing in around the top until the can is nearly round, the water goes down in the can about one-half inch. My contention is, that the cubical contents of the can are the same in either case. A. Your contention is not correct. You can see that it is not, if you will crush the can till its sides are nearly touching each other, when it will contain very little water, yet there is the same amount of metal in the can as when it is oval. The largest volume for a given amount of metal, that is, amount of surface, is found when the can is circular in outline, a cylinder with circular ends. A circle is the figure of largest area for its perimeter. Dent a circular can and it will not hold so much. Milk men know that.

(14273) S. T. K. asks: I would appreciate it if you would settle a point in geometry for me. In the accompanying diagram *two perfect* circles, respectively two and five inches in diameter are tangent to a *perfectly* straight line. Is there any difference in the size of the two points where the circles *actually* touch the line. A. The question you raise as to the tangency of two circles of different radii with a straight line, is not one of mathematics, but one of logic. The reasoning runs that a circumference curves continuously and uniformly. The continuous curvature of the circumference requires that no three points of the circumference can be in a straight line and that any two points will be in a straight line. Since a point has only position and not magnitude, two points on one circumference occupy the same space and are of the same size as two points on any other circumference. Points do not differ from another.

NEW BOOKS, ETC.

THE FLAG. By Homer Greene. Philadelphia: George W. Jacobs & Co., 1917. 12mo.; 318 pp.; illustrated. Price. $1.25 net.

The unmitigated villain is now seldom met in literature, even in the mystery yarn; this well-written story for boys, while it admits that there is some bad in the best of us, insists upon there being much good in the worst of us. It is a wholesome truth for the young to learn, is this lesson of charity, and "The Flag" teaches it by showing hot young blood in action in the schoolboy feud, on the farm, in the workshop, and finally on the western battlefront. The work has been aptly designated as "a kind of junior 'Man Without A Country;'" boys will like it, and their courage, loyalty and partiotism will be benefited by it.

METRIC TABLES. By Sir Guilford L. Molesworth, Past President of the Institution of Civil Engineers, etc. New York: Spon & Chamberlain, 1917. 104 pp. Price, 75 cents.

The author of the "Pocket-Book of Engineering Formulae" had been frequently urged to furnish that handy little vade-mecum with more complete metric tables; unwilling to increase its size, he has prepared a set of tables and has published them in uniform size with the "Pocket-Book." Thirty-three countries and their colonies use the metric system of weights and measures, the United States has adopted the metre and kilogram as the fundamental standards of length and weight, and the medical services of our Army and Navy and the Department of Public Health use this system exclusively. The little work is a very full compilation of tables and equivalents, and the advantage of having such a collection in so compact a form will be apparent.

MANUAL OF MILITARY AVIATION. By Hollis Leroy Müller, B.S., Major, Junior Military Aviator, Aviation Section, S. C., United States Army. Menasha, Wis.: George Banta Publishing Company, 1917. 12mo.; 308 pp.; illustrated. Price, $2.50.

TEN LESSONS IN BAYONET FIGHTING. By Sidney F. Mashbir, First Lieutenant Infantry, U. S. A. Menasha, Wis.: George Banta Publishing Company, 1917. Price, 75 cents.

INSPECTION GUIDE FOR INFANTRY TROOPS. By Eli A. Helmick, Colonel of Infantry. Inspector-General United States Army. Menasha, Wis.: George Banta Publishing Company, 1917. 16mo.; 51 pp.; illustrated. Price, 50 cents.

INFANTRY TRAINING. By Dale F. McDonald, Captain of Infantry, United States Army. Menasha, Wis.: George Banta Publishing Company. 1917. 16mo.; 145 pp. Price, $1.

FIELD ARTILLERY FIRING DATA AND NOTES. By Captain K. S. Perkins, Fifth Field Artillery. Menasha, Wis.: George Banta Publishing Company, 1917. 16mo.; 76 pp.; illustrated. Price 75 cents.

ORIGIN AND SIGNIFICANCE OF MILITARY CUSTOMS. By Major James A. Moss, U. S. A. Menasha, Wis.: George Banta Publishing Company, 1917. 8vo.; 78 pp.; illustrated. Price, 50 cents.

These war manuals appeal to various departments of military activity and each provides a condensed pocketful of information that may be studied in spare moments or even referred to in busy ones. Major Müller's "Manual of Military Aviation" has been prepared for the use of officers and men of the Army, the National Guard, and Reserve Corps, and for airmen in general. The author is holder of the American altitude record, and his experience, both in flying and in teaching has been thoroughly demonstrated; the work includes the military classification of aircraft of all descriptions, the duties of crews, the care of matériel, the fabrics of construction, and motors and equipment; there are chapters on meteorology and the navigation of the air, and the final section deals with the service in war, aircraft units, combat, reconnaissance, coast defense and naval service, and anti-aircraft defenses. "Ten Lessons in Bayonet Fighting" is a course given to the Junior and Non-commissioned officers of the 22d U. S. Infantry; it contains points hitherto neglected by similar publications, such as the psychology of the bayonet and an insistence upon the importance of aggressive fighting. Col. Helmick's "Inspection Guide for Infantry Troops" offers timely aid to the Inspection Officer and to the officers and men inspected: the need for system is emphasized, and a practical method of checking the field equipment of an infantry command is developed: this renders it unnecessary for the inspection officers to handle personally arms and equipment—an impossible task even under leisurely conditions; question sheets pertaining to the various companies are appended, and the ideas offered are worthy of the closest consideration. "Infantry Training" is a compilation of notes and suggestions, subject outlines and schedules, with a view to a more intensive and systematic course; the need for speed has become imperative; recent developments and changed conditions mean increased study for captains, many of whom have themselves had but insufficient preparation: this guide analyzes each subject in logical, progressive order, collects minor subjects under convenient main heads, and coördinates all toward the rounded efficiency of the unit in actions of combat or campaign. In "Field Artillery Firing Data" Captain Perkins has given us a selective compilation from Field Artillery Drill Regulations and other authentic upon at short notice to familiarize themselves with, or instruct others in, the manifold duties of the field artilleryman may have at hand in convenient form the necessary material for the computation of deflection, for determining parallel and divergent fire, etc. The service buzzer and its operation is explained, and there are instructions for agents, scouts and couriers. Major Moss gives us a most interesting glimpse into the "Origin and Significance of Military Customs" and the many unwritten laws of the Army; military weddings, the mode of addressing and saluting officers, army slang, the insignia of rank, the uniform, the flag—these are some of the subjects upon which light is thrown. The book should be read by civilians as well as by soldiers, for it chattily imparts knowledge that every patriotic man should possess.

THE JOURNAL OF SUBMARINE COMMANDER VON FORSTNER. Translated by Mrs. Russell Codman. With an Introduction by John Hays Hammond, Jr. Boston and New York: Houghton Mifflin Company, 1917. 12mo.; 190 pp.; illustrated. Price, $1 net.

Often we ask ourselves what can be the frame of mind of those who are commanding Germany's submarines and sending even women and children to untimely deaths as inexorably as though they had been made to walk the plank by pirates. Von Forstner was commander of the first German U-boat, and this abridged translation of his journal was evidently intended only for family circulation. Child life, it is said, reflects that of its savage ancestors; Von Forstner seems never to have emerged from this childish mixture of sentimentality and brutality; perhaps the most enlightening manifestation of character is the fulsome self-satisfaction that possesses him in recounting the rare occasions when he has shown mercy or courtesy to his victims. With what unction he continually refers to "Our Almighty War Lord," and with what venom to the hated enemy! Underwater life is faithfully sketched, and John Hays Hammond, Jr., has provided an introduction that places the whole submarine situation clearly before us.

THE SCOTTISH TRADE COURIER. Glasgow, Scotland: Fraser, Asher & Co., 1917. 4to.; 150 pp.; illustrated.

A most promising medium of reference makes its initial bow to the commercial interests in these lists of Scottish manufacturers and traders who wish to develop foreign and colonial business. Its four sections are in English, French, Spanish, and Russian, with classified indexes to each section. The establishment or extension of overseas trade is dependent upon making fresh channels of supply known to prospective buyers, most of whom are only too eager to acquire the information. Hence the service thus instituted by the Glasgow and West of Scotland Guardian Society and furnishing an authoritative list for their corresponding offices abroad, should result in bringing all the larger commercial houses into touch with buyers. The alphabetical index of trades shows that nearly three hundred activities are represented, and the information offered by the classified lists includes firm names and addresses, telegraphic address and code, and a recital of the specialties dealt in by the firm.

EARLIEST MAN. By Frederick William Hugh Migeod, F.R.A.I. New York: E. P. Dutton & Company. 8 vo.; 145 pp. Price, $1.

The writer's method of following the evolution of man from his simian ancestry has points of originality; in an incautious hand, it might degenerate into mere romancing, but great care has been taken not to credit any early brain with a capacity beyond the preponderant probabilities. These estimates of capacity were arrived at by intimate study, on the ground, of life in its most primitive and wild conditions; indeed, the manuscript was written in the Gold Coast Colony, in Bush stations and on the trail. The argument is guided by two considerations; first, that if a creature low in the scale of evolution can perform certain acts, another creature no lower, such as Pre-man, may not be denied an equal capacity; second, if there are natural occurrences that can cause lower species to act contrary to their usual habits and evince new mental activities, the same potential capacity must be allowed in the case of Pre-man. The "moving impulse for man's ascent" is ascribed chiefly to geological changes, and the whole subject is ably and readably handled.

RED, WHITE AND BLUE. By Lieut. Robert G. Schaefer. New York; John C. Rankin Company, 1917. 8vo.; 417 pp. Price, $1.25.

In this book are set forth unvarnished facts pertaining to the military condition of our country, with the object of enlightening the citizen as to his individual responsibility. Since we are no longer an isolated nation, all-sufficient unto ourselves, it is fitting that this survey should be extended to the military and naval establishments of the world, to "the struggles of men and nations for supremacy on land and sea, in the air and under the ocean; with war and all its implements, ancient and modern." This constant shifting of scenery and characters imparts life and action to the work, in the midst of which the main object is never forgotten. Pacificism is defined as a modern disease, and a remedial chapter is devoted to it that may be commended to the consideration of all advocates of unpreparedness. The work is at once a history, a protest against all things spineless and abject, an instruction-book in the paraphernalia and the prosecution of war, and an inspiration toward the unification of opinion and the highest development of both individual and organized effort against the Moloch

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Would your brakes hold in an emergency like this?

You are speeding peacefully along when suddenly a fire-engine shoots out of a side street. There is ten feet leeway in which to stop. You jam home the brakes and the engine goes across in front of you.

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A simple inspection now and then will insure continued safety.

Have your garage man look at your brakes today. Possibly only a simple adjustment is necessary to increase their efficiency.

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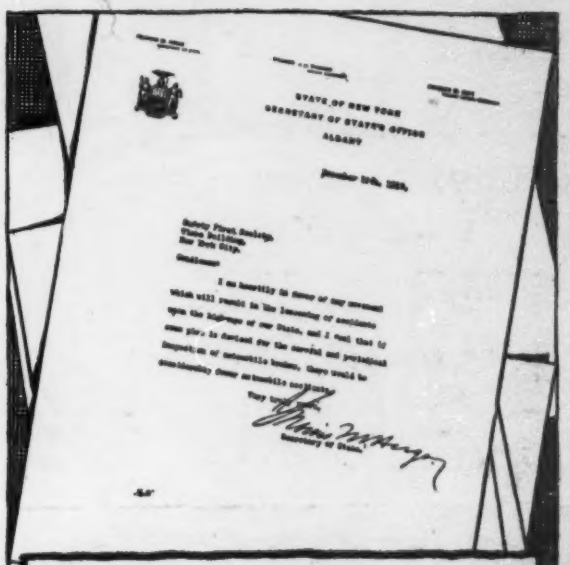


Brake Inspection Movement

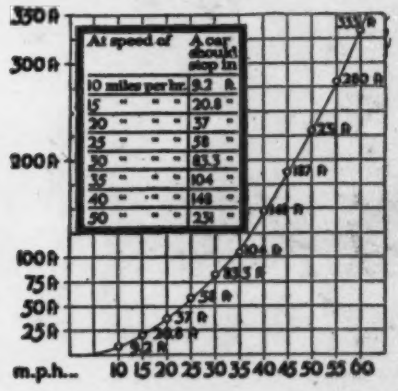
Prominent officials, leading clubs and organizations and motorists everywhere have endorsed this big national movement to reduce automobile accidents, by having all brakes inspected before the touring season begins and regularly thereafter. Give it your support.

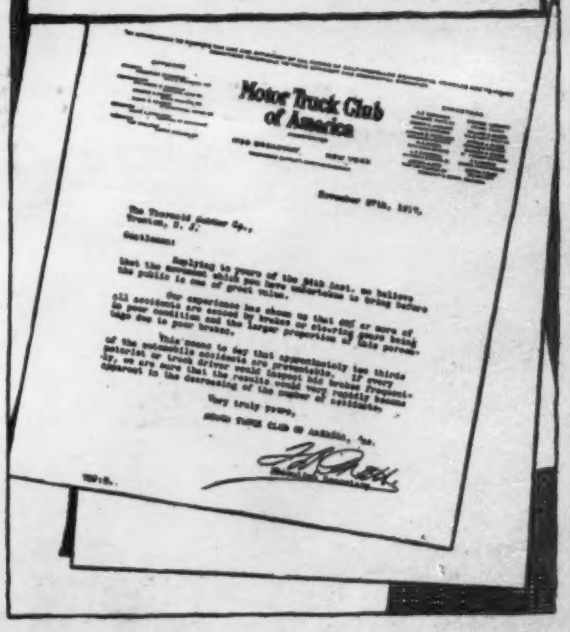
$\frac{V^2}{10.8}$ **Will your car do this?**

Automobile engineers have proved that when brake mechanism is right and road conditions average, any car should stop at distances and speeds given by the chart. V^2 means the square of the velocity or speed of your car; 10.8 is the proved factor of retardation under average road conditions. This factor decreases on smooth, slippery roads to 6.7 and increases as high as 17.4 on rough, worn roads. The chart represents the average condition and other conditions can readily be figured by changing the factor within the given limits.

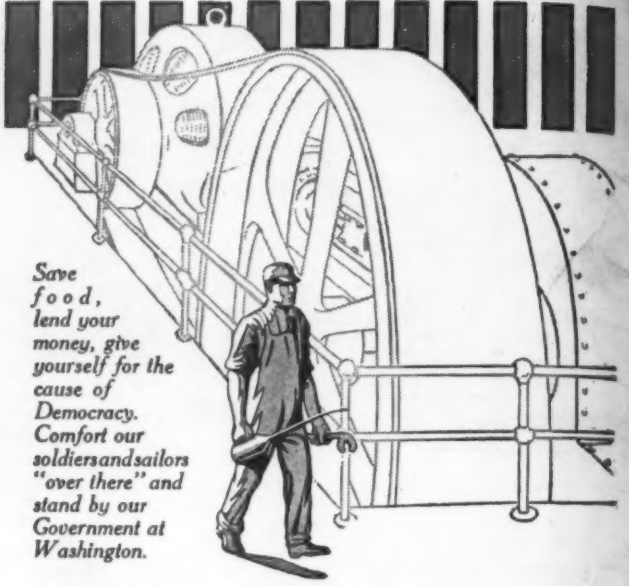
Remember that your brake mechanism is not "right" unless its brake lining has the ideal co-efficient of friction. The better the brake lining the quicker your stop.

Thermoid Brake Inspection Chart





Put Your Production "Over the Top"



Save food, lend your money, give yourself for the cause of Democracy. Comfort our soldiers and sailors "over there" and stand by our Government at Washington.

Man-power is decreasing and the shortage of labor will become more and more acute with each successive call for men to serve with the colors.

The only solution of the man-power problem is to increase mechanical efficiency.

In thousands of cases belting that lacks tractive power or is not specially adapted to the purpose for which it is used, is annually wasting more in motive power cost than several times the price of efficient belting equipment.

Thirty-four years' study of belt construction and operation has given this house comprehensive knowledge of every essential of the making and duty of belting.

Mechanical Rubber Goods

Hose specialists have developed the highest types of hose for steam use, air drills, pneumatic tools, chemicals, oils, acids, water, fire protection, spraying, etc.

Packing specialties include Daniel's P. P. P. Rod Packing, Daniel's Ebonite Sheet Packing and Ebonite Throttle Valve Packing. Each is the leader in its class.

Other lines of mechanical rubber goods include pump valves, gaskets, matting, moulded rubber articles, tubing; in short, everything made of rubber for mechanical service.

The complete line of Q. C. R. Co. products is described and illustrated in a 180-page catalogue which will be sent upon request to buyers or users of mechanical rubber goods.

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For certain classes of duty, the highest priced belt is not necessary; for other classes of service, the lowest priced belt costs the most ultimately.

The important thing is to select the brand specially adapted to the particular duty it must perform.

From the Q. C. R. Co. brands, you can select the belt that is exactly suited for main drives, dynamos, motors, lathes, looms, planers, beaters, exhaust fans, hot saws, cold saws, circular saws, emery wheels, conveyors, elevators, axle lights or drill presses for use in factories, saw mills, steel plants, paper mills, cotton gins, mines, oil mills or any other line of industry.

The brands shown below are *classes* of belts—*not* "grades."

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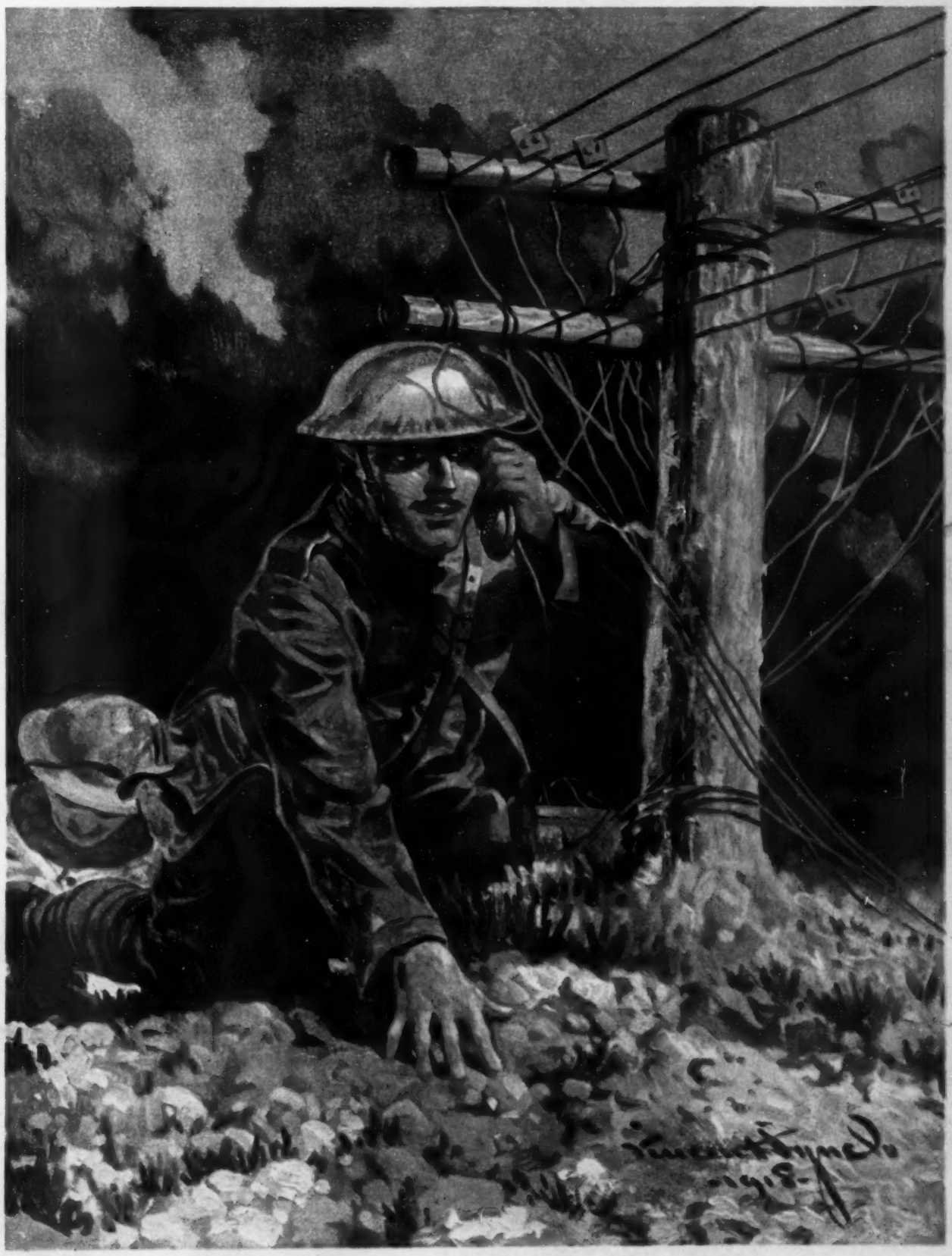

MILITARY TELEPHONE LINEMEN AT WORK UNDER ENEMY SHELL FIRE [See page 252]

March 23, 1918

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New York, N. Y.

Price 10 Cents